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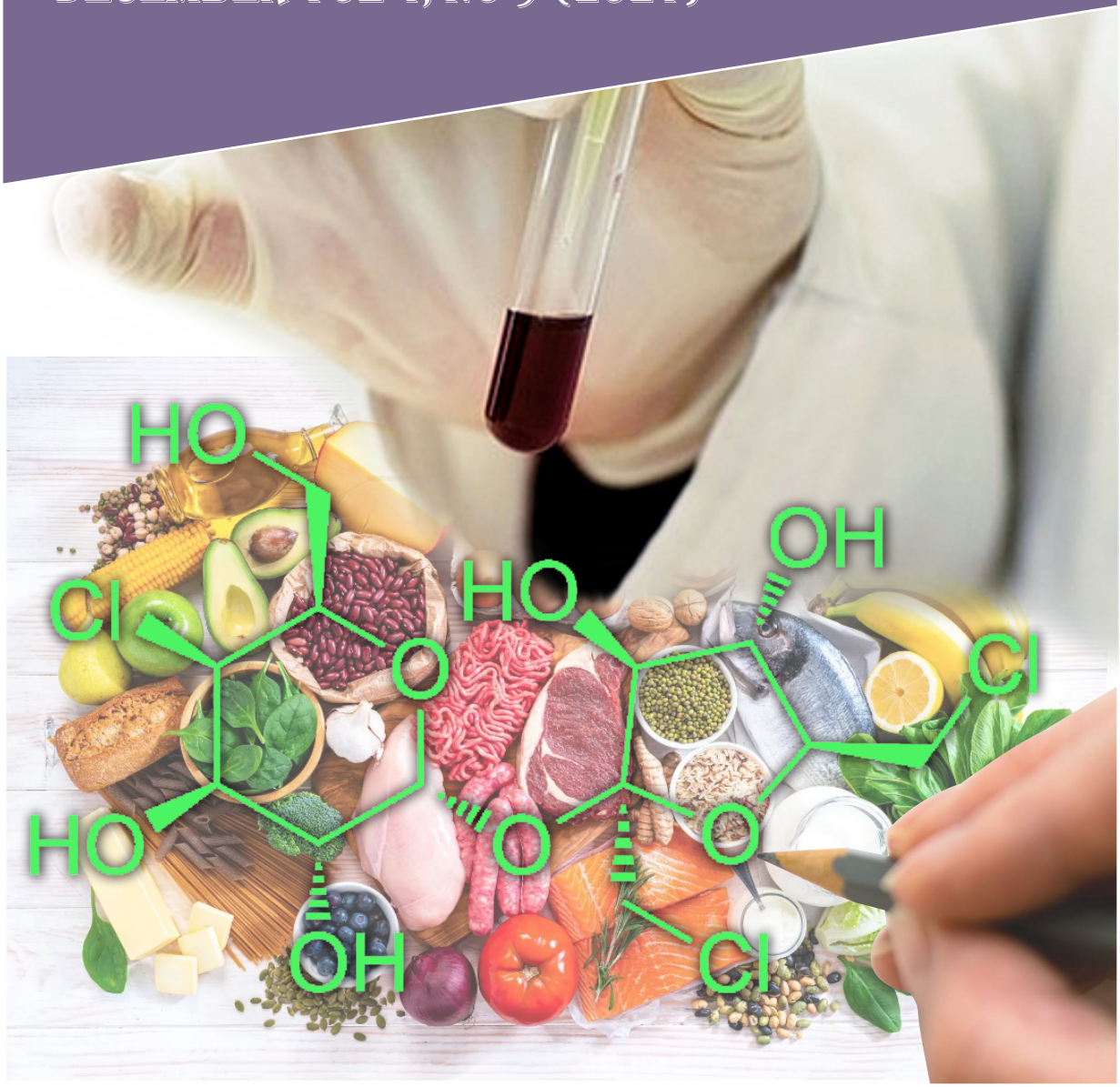

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TÜBİTAK ULAKBİM

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Research Article

EDITORIAL NOTE

Dear authors, reviewers and readers of Food, Health and Technology Innovations (FHTI).

It gives me great pleasure to welcome you to the fourth year and volume 4th (number 9) edition of Food Health and Technology Innovations for which I have acted as Editor in Chief..

Food Health and Technology Innovations (FHTI) is an international open access, peer-reviewed scientific research journal by DergiPark Ulakbim that provides rapid publication of articles in all disciplines of food science including food chemistry, food microbiology, food quality, food shelf life; food technology including conventional and innovative food processing; food engineering; nutrition including consumer nutrition and clinical nutrition; and their connected basic sciences including biochemistry, molecular biology, analytical chemistry, organic chemistry and connected applied sciences such as bioengineering, biomedical engineering, industrial engineering, mechanical engineering, material science, nanotechnology, nano sciences; health sciences including cancer science, cancer biology, hematology, oncology, surgery with clinical nutritive applications.

I would like to point out that the policy of top priority of FHTI is especially to put forward and to reveal the innovations and inspiring outputs for food, health and innovative technology applications. FHTI offers an exceptionally fast publication schedule including prompt peer-review by the experts in the field and immediate publication upon acceptance. Not only my deputy editorial concept but also the all editorial board aims the fast reviewing and evaluation of the submitted articles for the forthcoming issues. Our journal distinction is to make difference in this inspection point. In the context, Journal of Food, Health and Technology Innovations will continue to publish high quality researches on basic sciences and applied sciences..

Original research articles form the bulk of the content, with systematic reviews an important sub-section. We will encourage all authors to work to these standards. Such emphasis on methodological rigour is vital to ensure that conclusions reached from publications contained in the journal are valid and reliable. Peer review processing remains a vital component of our assessment of submitted articles to FHTI.

I would like to say that there is strong consensus which accepted articles are often improved by peer review after referees' comments and criticisms are dealt with; this explicit appraisal process also helps to engender trust of the reader. It is predicated that the criticisms of evaluating process containing publication delaying, unreliability of decision making as overly conservative approach. Besides, weaknesses can be managed by an effective and active editorial office, and I believe they are outweighed by the benefits. Lastly I should thank all our submitting authors, who have toiled in the production of their work, and have chosen Food Health and Technology as the journal they would like to publish in.

Have a great Publishing with FHTI…

Professor, Ozlem Tokusoglu, PhD

Editor in Chief
Food Health and Technology Innovations

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Proceeding Article

Promotion of Health via Nitrate Containing Foods

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Abstract

The main purpose of presented review is to meet foods include nitrate molecule and to examine how to promote health with daily intake diet. It was declared that nutrition type and it formulation is the most influence factor can be caused acute and chronic diseases. However, at the same time, this can also prevent some of heavy symptoms of those.

Keywords: Health, Nutrition, Functional Foods, Nitrate, Nitrite, Nitric Oxide

Introduction

Current human behaviors in daily nutrition include essential nutrients and bioactive compounds that demonstrate additional benefits to human health (Fardet & Rock, 2014). The presence of phytonutrients such as aminoacids, trace elements, vitamins and minerals protect us against to many diseases (Chomchan et al., 2018). Nothing affects our wellness more than what we choose to consume. Eating a well-balanced, nutritious diet and performing moderate exercise comprise the perfect model of good health. The role of a proper diet in the prevention of disease is well explained by many population-based epidemiological studies (Nunez et al., 2015). Humans are adapted to receive dietary nitrite (Nti) and nitrate (Nta) from birth and throughout life. It was reported that the absence of nitrite and/or nitrate in our foods or daily diets, can be involved in many of the chronic health problems. Improvements in science over the past 30 years have proved both the importance of Nti and Nta in our food supply and how our body makes these molecules naturally.

Today, with over 150,000 scientific papers published on nitric oxide (NO) molecule, a Nobel Prize awarded to the three US scientists responsible for its discovery, and a growing awareness around NO, it can no longer be ignored by medical healthcare practitioners. Surprisingly, there have been no hallmark therapeutic breakthroughs in terms of drug therapy around NO (Bryan, 2018). Perhaps this is due to the fact that NO itself may not be 'drugable' NO, once produced, has a half-life of less than 1 s (Kelm, 1999).

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Importance of consuming dietary nitrate and nitrite

Inorganic Nta and Nti are considered hazardous. There are legal limits to their concentration in food and drinking water. Nta, from fertilizer, accumulates in vegetables and fruit and seeps into groundwater. Therefore, keeping nitrate concentrations below legal limits is a huge struggle for agricultural applications. On the other hand, many of researchers were claimed that Nta and Nti should be considered as nutrients due to theirs health contributions when it consumed at the best ratio. The World Health Organization (WHO), US Food and Drug Administration (FDA), European Food Safety Authority (EFSA) and US Environmental Protection Agency (EPA) were conducted many studies about nitrate and nitrite presence in food, health and environment discipline. The result of those, it was declared that there are some concerns about consuming high ratio of inorganic Nta and Nti such as converting hemoglobin to methemoglobin, causing depression and carcinogenic nitrosamines. These outcomes were collected after animal experiments. However, the results from human experiment, it was expressed that Acceptable Daily Intake of Nti is max. 4.2 ppm (Katan, 2009). It was found too interesting that dietary Nta and Nti intake has shown weak toxicology and it can be harmless instead of taking inorganic Nta and Nti (Hord et al., 2009). This controversy situation was solved many medicinal and food researches over last decades.

The health effects of the dietary consumption of vegetables and fruit have been attributed to their constituents, including vitamins, minerals, fiber, and so-called nonnutritive substances such as polyphenols. One group of antioxidants present in fruits and vegetables is known as ′polyphenols′ or ′polyphenolics′ and is believed to neutralize free radicals formed in the body, thus minimizing or preventing damage to cell membranes and other cell structures (Milkowski et al., 2009). The Nta concentration of green vegetables (lettuce, spinach), cabbages, root vegetables (carrot, mustard leaf), melons (wax gourd, cucumber), eggplant and banana is changed between 12-387, 26-310, 70-195, 1-68, 25-42 and 4.5 mg/100 g fresh weight, repectively. On the other hands, the Nti concentration of cabbages, green vegetables, root vegetables, melons and eggplant is differed between 0-0.5, 0-0.2, 0-0.06, 0-0.01 and 0-0.04 mg/100 g fresh weight, respectively (Wang, 2000). The other rich sources of Nta and Nti are celery, cress, chervil, rocket (rucola), beetroot, radish, banana, pomegranate, acai and green tea (Santamaria, 2006). Several studies correlate healthy dietary patterns with lower plasmatic concentrations of pro-inflammatory markers (Centritto et al., 2009) whilst a meat-based dietary pattern (Western-type) is associated with higher levels of low-grade inflammation (Barbearesko et al, 2013). The current body of evidence shows that healthy dietary patterns have similar sides, such as a high intake of fiber, antioxidants, vitamins, minerals, polyphenols, monounsaturated, and polyunsaturated fatty acids (MUFA and PUFA, respectively); low intake of salt, refined sugar, saturated, and trans fats; and carbohydrates of low glycemic load (Mozaffarian, 2016). This can be generated via a high intake of fruits, vegetables, legumes, fish and seafood, nuts, seeds, whole grains, extra virgin olive oil and dairy foods together with a low intake of pastries,

soft drinks, and red and processed meat (Silveria et al, 2018).

The most recent literature has been heavily focused on beetroot plant and *Morinda officinalis* and *M. citrifolia* (Indian mulberry, noni fruit) (Wan et al., 2019; Yang et al., 2019; Yoshitomi et al., 2020; Kim et al., 2020; Lee at al., 2020a; Lee at al., 2020b). The beetroot is a source of bioactive compounds, including phenolic compounds, saponins, and especially betalains (Mroczek et al., 2012). The antioxidant capacity of the betalains and phenolic compounds suggest a protective role regarding oxidative processes (Georgiev et al., 2010). The beetroot is a Nta-rich food product that is absorbed in the proximal intestine. This plant is a good source of endogenous Nti and nitric oxide (NO) (Lundberg & Weitzber, 2005; Coles & Clifton, 2012). Nti and Nta are vaso-active agents with the ability to increase vasodilatation, decrease blood pressure (BP), and improve cardiovascular function in both healthy individuals (Coles & Clifton, 2012; Miller at al., 2012) and hypertensive patients (Kapil et al., 2014). The dietary administration of Nta caused an acute reduction in systolic and diastolic BP in healthy subjects, after the ingestion of 500 mL of beet juice (Webb et al., 2008). Moreover, beetroot intake has been associated with improved performance and increased tolerance to exhaustion during sportive activity (Lundberg at al., 2009). On the other hands, *M. officinalis* have various biological activities, including protecting against bone loss, osteoporosis, age-induced bone degeneration, and have anti-oxidant, anti-fatigue and anti-inflammatory activities. Some of polysaccharides, flavone glycosides,iridoid,glycosides, anthraquinon, coumarins, and phytosterols, such as rubiadin, rubiadin-1-methyl ether, 2-hydroxy-1-methoxy-anthraquinone, 1,3,8 trihydroxy-2 – methoxy - anthraquinone, morindolide, morofficinaloside, asperuloside, asperulosidic acid, monotropein, scopoletin, stigmasterol, daucosterol, and sitosterol molecules are responsible for those health promotion effects (Lee at al., 2017). Noni was one of the most important medicinal plants for Polynesian people, who used it for multiple reasons, among which was also the treatment of diabetes (Algenstaedt et al., 2018). *M. citrifolia* leaf is consumed raw as vegetable salad called “ulam” and “kerabu” in Traditional Malay Medicine to prevent hypertension and aging and to invigorate the blood (Chong et al., 2018).

Biochemical pathways of NO_x molecules and medical studies

Nitric oxide (NO) and derived molecules, called reactive nitrogen species (R*NS), are novel modulators of diverse physiological processes (Corpas & Palma, 2018). The excellent physiologically redundant mechanisms by which Nti and Nta are produced and reformed by oxidation of NO are illustrated in **Figure 1**. Dietary sources of Nti and Nta may boost the reserve of compounds for optimum function through periods of physiological stress and diseases termed by endothelial dysfunction (Bryan et al. 2007; 2008).

The degradation of Nta to Nti to NO is, by necessity, an inefficient process by which each step yields a 3-log-lower concentration of product than substrate. Therefore, a 10 ppm infusion of Nta given over 5 min yielded a plasma concentration of Nti of ~1 μmol/L and resulted in ostensibly NO–mediated vasodilation after experimentally induced ischemia (Jansson et al., 2008). Notably, the short half-life of NO results from efficient oxidation of NO to Nti and other nitrogen oxides, such as *N*-nitroso compounds by NO oxidases that use transition metals in their active sites, such as copper-containing ceruloplasmin (Shiva et al., 2006), myeloperoxidase, and even endothelial NO synthase (Vanin et al., 2007). Oxidation of NO to nitrite and nitrite to nitrate contributes to the pool of NOx compounds that serve as signaling molecules systemically or as a local substrate for nitric oxide production. Emerging evidence from animal models and human clinical studies indicates that Nti performs unique intracellular signaling properties that mediate physiologic infusion in humans induces rapid local vasodilation, reduces blood pressure acutely, serves as an endocrine reservoir of NO, and, unlike organic nitrates, does not induce tolerance (Dejam et al., 2007; Webb et al., 2008). Nti has also been shown to play a role in mitochondrial respiration (Nohl et al., 2000), cardiac function (Rassaf et al., 2007), activation the α- form of the estrogen receptor (Veselik et al., 2008), and exertion of antiapoptotic effects (Gonzalez et al., 2008). Because Nti is a biologically active compound resulting from Nta reduction in tissues, significant physiologic benefits may be associated with the provision of Nti from dietary sources functions independent of its role as a source of NO in tissues by reduction (Bryan, 2006). The reactive nitrogen species (RNS) are mainly produced through mitochondrial activity and other pathways, such as nitric oxide (NO) synthase, and oxidase enzymes, such as Nicotinamide adenine dinucleotide phosphate (NADPH) oxidases (Nox), xanthine oxidase (XO), lipoxygenase, myeloperoxidase, uncoupled endothelial nitric oxide synthase (eNOS), and the mitochondrial respiratory chain via a one-electron reduction of molecular oxygen. Note the role of Nox in oxidative stress, as upregulated and overactive Nox enzymes contribute to oxidative stress and cardiovascular disease (CVD). Increased oxidative stress through production of superoxide can scavenge NO thereby reducing its effective concentrations and signaling actions in. Aging also causes a decrease in NOS enzyme expression. There is also an upregulation of arginase (an enzyme that degrades the natural substrate for NOS, L-arginine) in the blood vessels as we age that causes a reduction in NO production due to a shuttling of L-arginine away from the NOS enzyme. Aging causes a gradual decline in NO production with a greater than 50% loss in endothelial function in some aged populations. Some studies show a more than 75% loss of NO in the coronary circulation in patients in their 70s and 80s compared to young, healthy 20-year olds (Bryan, 2018).

NO is an important mediator of blood pressure homeostasis. It has been reported that pharmacologically reducing the bioavailability of NO can lead to hypertension in NRs (Ribeiro et al., 1992). Furthermore, it is strongly suggested that loss of the vasodilatory action of NO is a main cause to the development of hypertension in some forms of the disease (Naseem, 2005). NO is essential for

maintaining normal blood pressure, preventing adhesion of blood cells to the endothelium, and preventing platelet aggregation; it may, therefore, be argued that this single abnormality, the inability to generate NO, puts us at risk for diseases that plague us later in life, such as atherosclerosis, myocardial infarction, stroke, Alzheimer's disease, and peripheral vascular disease. Therefore, developing strategies and new technologies designed to restore NO availability is essential for inhibiting the progression of certain common chronic diseases. The provision of dietary nitrate and nitrite may allow for such a strategy. NO is also one of the most important molecules produced within the cardiovascular system that maintains normal blood pressure and prevents inflammation, immune dysfunction, and oxidative stress, hallmarks of cardiovascular disease. **Figure 2** shows that the main causes of CVD. Mediterranean and Dietary Approaches to Stop Hypertension (DASH) dietary interventions are well studied for cardiovascular outcomes. Both dietary patterns can reduce the ratio of CVD through the down-regulation of low-grade inflammation and better control of body weight, which also improve other risk factors, and are correlated with lower numbers of clinical events (Mozaffarian, 2016; Silveria et al, 2018).

Dietary intake of Nta is a well-known marker of a health-promoting fruit and vegetable diet. This could be providing via dietary or supplementary nutrition (food supplements) or food additives. The importance of dietary variety, balance and moderation should be stressed along with the importance of protective factors in the total diet, combined with a physically active lifestyle. The risk or benefit balance should be a strong consideration (Milkowski et al., 2009) before there are any suggestions for new regulatory or public health guidelines for dietary nitrite and nitrate exposures. Dietary supplementation of nitrate from food supplements is challenging with regard to daily intake, in order to provide a ready, easy to administer, attractive, nitrate-rich food product with the aim of promoting beneficial effects on the cardiovascular system (Davi Vieira Teixeira da Silva et al., 2016).

Conclusion

Some of the dietary patterns and clinically proven specific foods have significant protective effects for many of human diseases. This review will highlight the biochemical and physiological base for consumers and patients. This study also reveals the beneficial effects of nitrite and nitrate and their metabolism may be affected by lifestyle and diet. Well-balanced nutrition plays a key role in reducing the risks of different chronic diseases. The objective of this review is to summarize the scientific findings and illustrate how diet and lifestyle break NO production down, and, most importantly, illustrate how we can overcome these obstacles to optimize NO generation.

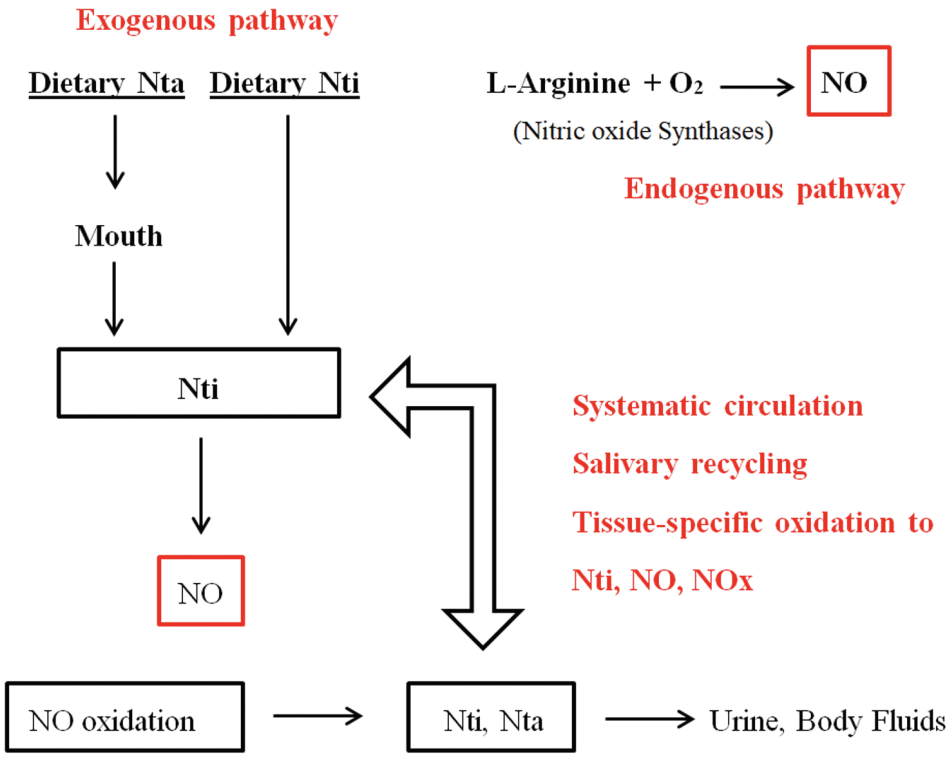

Figure 1. The physiological disposition of nitrate, nitrite, and nitric oxide (Hord, 2009)

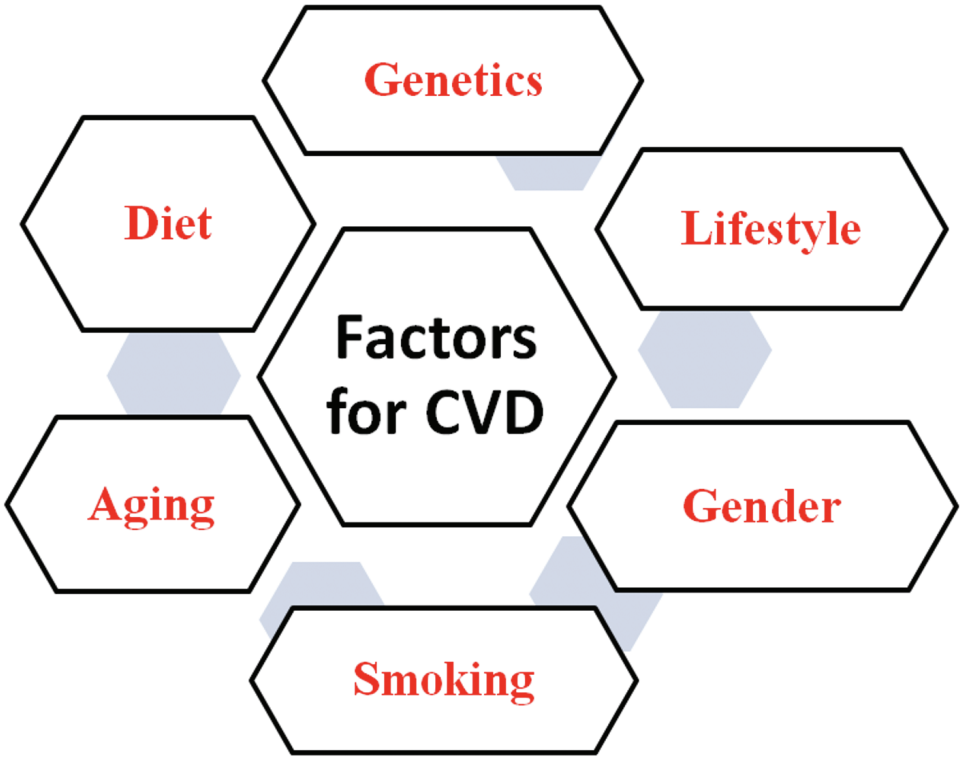

Figure 2. The possible causes lead to the development of cardiovascular disease (CVD) (Casas, 2018).

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Proceeding Article

Drug Protocols on Prostate Cancer Clinic Studies

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Abstract

In this review article, used drug protocols on prostate cancer clinical studies. The review cover the possible treatment options include surgery, radiotherapy (RT), hormonal therapy, chemotherapy (CT), immunotherapy or a combination of these depending on the stage of the disease or the medical condition of the patient in prostate cancer cases.

Keywords: Prostate cancer, PCA, drug, protocol, case, anti carcinogen

Introduction

Of 175,000 new cases of prostate cancer (PCa) diagnosed in the United States (USA) in 2019, 6% presented with metastatic disease, and every year, despite the growing number of treatments, more metastases cases emerge. It is estimated that the global PCa-related mortality will be 385.560 in 2020 (1). The single PCR incidence study reported from Turkey was conducted in Izmir. In that study, PCa was determined as the fifth most common cancer with an incidence of 13.8 per 100000 based on the data from 1998 to 2002 (2).

In PCa, treatment options include surgery, radiotherapy (RT), hormonal therapy, chemotherapy (CT), immunotherapy or a combination of these depending on the stage of the disease or the medical condition of the patient.

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Anticarcinogenic Medical Agent Groups

Luteinizing hormone-releasing hormone (LHRH) agonists *(leuprolide, goserelin, buserelin,* and*triptorelin)* exhibit their effect by down-regulating LHRH receptors, thereby reducing follicle stimulating hormone (FSH), luteinizing hormone (LH) release and testosterone (T) production (Schally et al.,1971).

LHRH agonists have become a standard in the hormonal treatment of PCa due to their recyclability, compliance with intermittent androgen deprivation therapy (ADT), and causing no physical or mental problems related to orchiectomy, as well as their efficacy in oncological treatment (Mc Leod et al.,2003; Seidenfeld et al.,2000).

LHRH antagonists *(degarelix, abarelix, cetrorelix)*, competitively bind to LHRH receptors in the pituitary, resulting in a rapid decrease without causing an increase in LH, FSH and T levels (Debruyne et al.,2006; Klotz et al., 2008; Tombal et al., 2010).

However, despite their low cost, clinical trials with a large series are needed before they can be routinely used.

Antiandrogens: Male sex hormones in steroid structure consisting of T and dihydrotestosterone (DHT) are from the testicle at 90-95% and adrenal gland at 5-10%. Ninety-five percent of T, which enters the prostate cell, turns into DHT through the enzyme 5α-reductase. Antiandrogens compete with T and DHT in the binding sites of receptors in the prostate cell nucleus. Thus, while stimulating apoptosis, they also inhibit the growth and development of cancer cells. According to their chemical structure, antiandrogens are divided into two groups as steroidal and non-steroidal (Kokontis et al.,1999).

Steroidal antiandrogens are synthetic derivatives of hydroxyprogesterone (*cyproterone acetate, megestrol acetate, medroxyprogesterone acetate*). In addition to blocking androgen receptors (AR) in the periphery, they exhibit central effects, reducing the levels of LH, and thus lowering T. They also suppress adrenal activity by inhibiting gonadotropin release. They are not recommended for use in monotherapy (Moffat et al.,1990).

Since they lower the T level, their main side effects include loss of libido, erectile dysfunction, cardiovascular toxicity, hepatotoxicity, and gynecomastia.

Non-steroidal antiandrogens *(flutamide, nilutamide, bicalutamide, apalutamide, enzalutamide, daralutamide)* show their effects by blocking T receptors and do not reduce the T level; therefore, they preserve libido, physical performance, and bone mineral intensity, thus providinga better quality of life than after castration. Common side effects of these agents include gynecomastia, chest pain, hot flashes, and hepatotoxicity (McLeod et al.,1997; Dalaere et al.,1991).

Suppressants of adrenal androgens *(ketoconazole, aminoglutethimide, glucocorticoids)*: The serum T level decreases by about 90% after medical or surgical castration. Until the 1970s, bilateral adrenalectomy was implemented to suppress adrenal androgens today the same effect is achieved with drugs (Lam et al.,2006).

Ketoconazole, an antifungal, reduces androgen biosynthesis by P450 demethylase inhibition (De Coster et al.,1996).

Aminoglutethimide blocks adrenal steroid synthesis by inhibiting both enzymes involved in corticosteroid synthesis and aromatase enzyme (Shaw et al.,1988).

Glucocorticoids suppress adrenal androgens by providing negative feedback to the pituitary and hypothalamus in the central nervous system(Lam et al.,2006).

Estrogens are effective through the basic mechanisms of reducing LHRH and LH release by negative feedback, suppressing T production by direct testicular and adrenal effects, and direct cytotoxic effects on PCa cells (13). The most used estrogen is *diethylstilbestrol* (DES); however, its use is limited due to serious cardiovascular side effects.estrogenic preparations, such as *PC-SPES*, *Premarin*, and *transdermal estradiol* or estrogen receptor inhibitors, such as *tamoxifen* and *raloxifene* can also be used in PCa (Lam et al.,2006; Zhang et al.,2015; Salata et al.,2019).

Chemotherapeutics have been investigated by the National Prostate Cancer Project (NPCP) in several randomized studies as single agents or in combination in PCa patient groups and were first called 'hormone-resistant', then referred to as 'castrate-resistant' (CRPCA). Agents, such as *cyclophosphamide*, *cisplatin*, *carboplatin*, *satraplatin*, *5-fluorouracil* (5-FU), *doxorubicin*, *vinblastine*, *etoposide*, *methotrexate*, *estramustine*, *docetaxel*, and *mitoxantrone* have been tested, with some earning their place in routine treatment (Naderet al.,2018).

Immunologicagents (e.g., *Spilucel-T*, *Prostvac, Gvax, ipilimumab, tremelimumab, nivolumab*, *cabozantinib, pembrolizumab, lambrolizumab, avelumab*, *atezolizumab*, *durvalumab)* and therapeutic anti-cancer vaccines, including those that are dendritic cell-based, whole cell-based, and vector-based are the main immunotherapeutic strategies used in the treatment of PCa (Harris et al.,2018).

TREATMENTS IN LOCALIZED PROSTATE CANCER

In the American Association of Urology (AUA) guidelines, clinicians are advised not to administer neoadjuvant systemic therapy other than neoadjuvant ADT or clinical trials if the localized PCa case has chosen to undergo radical prostatectomy (RP) (Sanda et al.,2018).

Localized high-risk or local advanced stage PCa: Of newly diagnosed PCa cases, 17–31% present with localized high risk or locally advanced disease, for which curative treatment is required (Cooperberg et al.,2008).

If these cases are not treated, 10 and 15 year PCa-specific mortality rates can reach 28.8% and 35.5%, respectively (Rider et al.,2013).

Combined local or systemic applications are used in treatment modalities. ADT alone should not be considered as a viable treatment option in high-risk and locally advanced PCa. Currently, the European Association of Urology (EAU) PCa guidelines recommend a multimodal approach in pelvic lymph node dissection and RP, and possibly adjuvant RT ± ADT after surgery or 76-78 Gy external beam RT (EBRT) or long-term ADT combined with brachytherapy (BT) and EBRT in patients with a life expectancy of more than 10 years (Mottet et al.,2019).

Evidence pertaining to treatment methods is still lacking, and patients are treated on the basis of clinical experience rather than receiving evidence-based treatment.

Treatments in addition to radical prostatectomy: Studies reveal that post-RP early ADT is more beneficial than delayed ADT. In some studies comparing RP and RT, there was no statistical difference in terms of distant metastasis-free survival between RP and EBRT + ADT, whereas the superiority of RP was reported in relation to overall mortality, PCa-specific mortality, overall survival (OS), and cancer-specific survival (CSS) data (Boorjian et al.,2011; Yamamoto et al., 2014).

When the results of literature studies are examined, it is seen that early EBRT after RP provides improvement in biochemical and clinical disease-free survival in addition to OS in patients with locally advanced PCa. In a study comparing RP without any

additional treatment with MaxRT (EBRT + BT + ADT), the former resulted in higher PCa-specific mortality and overall mortality rates, but no difference was observed in the results when compared to RP + adjuvant RT and/or maxRP (RP + RT + ADT) (Tilki et al.,2018).

In a study applying adjuvant bicalutamide after RP, OS or CSS advantage was not shown after an average of follow-up of 11.2 years (Iversen et al.,2010).

In another study, after 10 years of follow-up with neoadjuvant ADT, both biochemical disease-free survival and positive contributions to OS were reported (Fujita et al.,2017).

In another study, neoadjuvant LHRH analog was compared with pre-RP CT (estramustin, oral etoposide, and paclitaxel) and its positive contributions to overall mortality and biochemical disease-free survival were noted (Ferris et al.,2018).

CT applications before RP: Recently, there has been a growing interest in neoadjuvant therapy in order to eliminate micrometastases and improve surgical outcomes in a variety of cancers. However, there are only limited data due to the absence of mature Phase III studies evaluating the role of neoadjuvant CT in PCa and the use of different CT agents and a limited number of patients in Phase II studies. The use of neoadjuvant CT before RP is still under investigation and is currently not a standard part of treatment in patients with PCa.

CT after RP: In the GETUG 12 trial, stage T3-T4 disease, Gleason score ≥8, PSA level >20 ng/ml or lymph node dissection positive disease were accepted as high-risk features. The 8-year disease-free survival was 50% in the ADT arm, and they showed that the ADT + docetaxel and estramustin combination arm was superior with 62% (Fizazi et al.,2015).

In a study conducted by the Scandinavian Prostate Cancer Group (SPCG) overa mean follow-up of 56.8 months, the biochemical progression rate was 44.8% in the study arm containing docetaxel and 38.9% in the surveillance arm, and the authors concluded that there was no benefit or potential harm of adding docetaxel to the treatment of high-risk PCa patients after RP (Ahlgren et al., 2016).

Combined hormone-radiotherapy: Many controlled randomized trials have shown that combined ADT + EBRT therapy has a survival advantage over the use of these treatment options alone. In studies comparing EBRT alone with EBRT + ADT, the positive results of combined therapy have also been reported (29,34,35). In the comparison of the groups formed by the addition of EBRT + ADT and docetaxel, it was determined that although the docetaxel group provided superior results in terms of OS, the rate of toxicity associated with CT and mortality associated with treatment were significantly higher (Rosenthal et al., 2015;Carles et al.,2019).

CT after radiotherapy: One of the most promising studies evaluating CT after RT is the phase III study conducted by Sandler et al., who randomized 563 high-risk PCa patients to ADT+RT or ADT+RT, followed by docetaxel and prednisone treatments, respectively. The four-year OS increased from 93% in the ADT + RT arm to 93% with the addition of docetaxel. Furthermore, there was a 10% increase in the six-year disease-free survival rate in the docetaxel group. In light of these results, adjuvant docetaxel in addition to RT for the treatment of PCa cases with high-risk disease was included in the treatment proposal of appropriately selected patients in the National Comprehensive Cancer Network (NCCN) guidelines (Sandler et al.,2015).

TREATMENTS IN METASTATIC PROSTATE CANCER

LHRH agonists and antagonists: In studies comparing an LHRH agonist *leuprolide acetate* and an LHRH antagonist *degarelix*, the latter was found to reduce T similar to but faster than the former and without exacerbation. Furthermore, using degarelix, PSA progression and PCa-specific death were less common in advanced-stage patients (Klotz et al., 2008; Tombal et al., 2010).

However, the use of this agent is limited due to the serious and life-threatening side effects mediated by histamine in 5% of cases during treatment. Another LHRH antagonist, *abarelix*, has not been widely adopted due to rapid onset allergic reactions caused by histamine release (Debruyne et al.,2006).

Antiandrogen monotherapy: Compared with goserelin, the use of *steroidal antiandrogens* alone has poorer survival data. Among *non-steroidal antiandrogens*, *nilutamide* and *flutamide* applied as monotherapy have contradictory results. *Bicalutamide* monotherapy can be the treatment option for locally advanced or carefully selected patients with low PSA (Tyrrell et al.,1998 a,b).

In a study comparing flutamide and orchiectomy, no difference was found between the two groups in terms of survival; however, side effects were more common in the flutamide group (Boccon et al.,1997).

In another study comparing flutamide and DES, the authors reported the time to progression similar in both groups but OS time was shorter in the former (Chang et al.,1996).

In another study by Schröder et al. comparing *flutamide* and *cyproterone acetate*, the results of the groups were similar in terms of OS and progression-free period, while side effects were more common in the flutamide group (Schröder et al.,2004).

In a meta-analysis conducted with advanced stage PCa patients, non-steroidal antiandrogens were reported to be associated with lower OS compared to LHRH agonists (Seidenfeld et al.,2000).

Similarly, in a study conducted with 1,453 locally advanced and metastatic PCa patients, 150 mg/day bicalutamide was compared with surgical or medical castration, and it was determined that bicalutamide was not as effective as castration in terms of OS results. However, quality of life parameters were found to be better in the bicalutamide group, but gynecomastia and breast sensitivity were also higher among these patients (Tyrrell et al.,1998 b).

In the only randomized study comparing steroidal and non-steroidal antiandrogens as monotherapy, *cyproterone acetate* and *flutamide* were found to be equally effective in CSS and OS over an 8.5-year follow-up (Schröder et al.,2004).

Estrogens: DES, a synthetic estrogen, affects LHRH or the pituitary gland and suppresses the release of LH, thereby lowering the T level. However, the interest in this drug diminished beginning with the publication of the Veterans Administration Cooperative Urological Research Group (VACURG) study, which showed an increased risk of cardiovascular death after DES treatment at a 5.0 mg dose (Bailar et al.,1970).

In terms of efficacy, many studies comparing DES with primary hormonal therapy in patients with metastatic PCa compared with other ADTs did not detect any difference in patient survival. However, most studies have shown that DES is associated with severe cardiovascular toxicity requiring discontinuation of therapy, especially at 3.0 and 5.0 mg/day doses. These results suggest that DES should no longer be used at doses higher

than 1 mg per day. Recent clinical data also strongly suggest that parenteral administration of estrogen can overcome the thromboembolic cascade of events related to oral administration(Reis et al.,2018).

Maximal androgen blockage (MAB): The goal of this treatment is the suppression of not only androgens originating from the testicles, but also adrenal androgens. In addition to castration (surgical/LHRH agonist), both biochemical and clinical improvements are achieved in more than 90% of cases with the use of antiandrogen. In a study by Labrie et al., 97% positive objective response was achieved with *buserelin* and *nilutamide* therapy over an average of 4.2-month follow-up. The authors suggested that with MAB, only 25-30% more responses would be obtained against testicular androgen blockade (Labrie et al.,1983).
Crawford et al. compared *leuprolide* + placebo with *leuprolide* + *flutamide* treatments, and after four years of follow-up, they determined the time to progression as 13.9 months versus 16.5 months and survival times as 22.3 months and 35.6 months, respectively, indicating statistically significant differences between the two groups (Schröder et al.,2004).

Denis et al., compared orchiectomy + placebo with *goserelin* + *flutamide* treatments, reporting that MAB was significantly more effective in terms of the duration of progression and survival (Denis et al.,1998).

In contrast, in other studies comparing *goserelin* + *placebo* with *goserelin* + *flutamide*, and comparing orchiectomy alone with *orchiectomy*+ *flutamide* treatments, the authors did not observe any significant difference between the groups (Fourcade et al.,1990; Eisenberger et al.,1998).

Intermittent androgen deprivation is a form of treatment in which tolerance and quality of life are better and costs are reduced through the discontinuation of treatment at times when serum androgens reach their normal levels (Abrahamsson et al.,2010).
When PSA is reduced by 80% from its basal value, the drug is interrupted, and the treatment is restarted when there is a 50% increase in PSA compared to the level at the time the drug is stopped. In a study by Leval et al., groups receiving continuous and intermittent treatments were compared. After a three-year follow-up, the progression rates were 7% in the intermittent treatment group and 39% in the continuous treatment group (De Leval et al.,2002).

Early or delayed treatment: The time to start hormonal therapy in patients with advanced PCa remains controversial. In studies comparing early and late treatments in advanced-stage patients, it was concluded that early treatment had better results in terms of complications related to progression and disease progression, but no improvement was observed in cancer-specific survival (Byar et al.,1973; Jordan et al.,1977).

There is no definite consensus on when to start hormonal treatment in asymptomatic advanced stage patient (Morgan et al.,2009).

Addition of CT to first-line treatment in metastatic disease: For metastatic hormone-sensitive PCa, the cornerstone of treatment targets the androgen tract, but most of these patients progress to CRPCA within one to two years. The mechanism of action of *docetaxe* has led to the idea that it may also be beneficial for hormone-sensitive PCa, which has opened the way for new research (Shenoy et al.,2016).

In a study conducted by the Genitourinary Group and the French Association of Urology (GETUG-AFU), the role of

docetaxel was evaluated in 385 men with metastatic hormone-sensitive PCa. The patients were randomized into groups to receive *ADT alone* or *docetaxel + ADT*. The result was that there was no difference between the groups in OS, and side effects were more common in the combined treatment group. The authors concluded that the study did not support the use of docetaxel in the first-line treatment of patients with metastatic hormone-sensitive PCa (Gravis et al.,2013).

In another larger study (the CHAARTED study with ECOG), docetaxel + ADT treatment in patients diagnosed with de-novo castration-sensitive prostate cancer prolongs the time to castration resistance and results in better cancer control, especially for the high-volume disease group (Sweeney et al.,2015).

To date, the STAMPEDE study the largest work to investigate the efficacy of various treatments, including *docetaxel* and *zoledronic acid* as pretreatment with hormonal therapy in men diagnosed newly diagnosed with PCa. Improvements in survival were achieved in patients receiving docetaxel with standard therapy. However, subgroup analyses showed that patients with non-metastatic disease did not benefit from this additional treatment. The authors concluded that standard care should include docetaxel treatment for those with disease metastatic, castrate-sensitive disease(James et al.,2016).

Cyclophosphamide is an alkylating agent that affects cell division by crosslinking deoxyribonucleic acid (DNA) strands, and thereby reducing DNA synthesis. In an NPCP study, full response was reported in none of the patients, and partial response was achieved only in 7%, with stable disease being observed in 26-46% of patients (Yagoda et al.,1993).

Later, although cyclophosphamide was reused with an interest in its role in angiogenesis inhibition via the metronomic cycle, this drug was mainly discussed in terms of its use in cases where docetaxel had failed (Ladoire et al.,2010).

Cisplatin inhibits DNA synthesis by crosslinking DNA strands. Studies have reported the partial remission rate as 12%, which indicates a moderate antitumor activity, and therefore cisplatin is still being investigated in terms of its effects as a single agent and in combination with other treatments (Yagoda et al.,1993).

Carboplatin has been studied as a single agent with minimal effects. However, when combined with other CT drugs, such as paclitaxel and estramustine, significant decreases in serum PSA levels were seen (Kelly et al.,2001).

Satraplatin, a fourth-generation platinum analog, has been found to be effective against cisplatin- and carboplatin-resistant cell lines. It has also been shown to be beneficial to relieve pain in patients with CRPCA, but no positive contribution to OS has been reported in Phase III trials (Figg et al., 2013; Sternberg et al.,2009).

5-fluorouracil, is a pyrimidine analog that suppresses DNA synthesis by inhibiting thymidylate synthetase. Studies have shown the modest antineoplastic activity of this agent. *Doxorubicin* intercalates between DNA base pairs and inhibits replication and transcription, disrupting the function of topoisomerase II. In an NPCP study, it was reported to have clinical benefits with a response rate reaching 84%, including stable disease (Eisenberger et al.,1985).

Subsequent studies using *vinblastine* and *etoposide* alternating with additional *ketoconazole* with doxorubicin did not show any additional benefit compared with hormonal therapy alone (68). In one of the studies comparing *doxorubicin* with *5-FU*, 25% clinical response was achieved with doxorubicin, while this rate remained at 8% in those treated with 5-FU alone (DeWys et al.,1983).

Methotrexate is a dihydrofolic acid reductase inhibitor that inhibits purine and thymidyl acid synthesis and serves to interfere with DNA synthesis. Studies have shown that it can provide stable disease at a rate of 20% (Murphy et al.,1988).

Etoposide replaces DNA replication, induces G2 phase stop, and kills cells in G2 and late synthesis phases. Studies have shown the overall response rate to bepoor at 3% (Trump et al.,1984).

Vinblastine is a vinca alkaloid that prevents microtubule formation. The few available studies have shown a 21% remission rate(Eisenberger et al.,1988).

Estramustine is an estradiol with antiandrogen and antimicrotubule effects and a combination of nor-nitrogen mustard carbamate. It has been extensively studied by NPCP and reported to have an effect on CRPCA patients, but an objective response has been rarely seen in studies. Similarly, when estramustine was examined in combination with *prednimustin*, *vincristine* and *cisplatin*, no noteworthy additional benefit was shown (Eisenberger et al.,1988).

While subsequent studies combining estramustine with *docetaxe* provided promising results, it was noted that the efficacy of treatment was higher due to docetaxel, and the use of estramustine was almost completely abandoned due to its side effect profile (Figg et al., 2007).

Mitoxantrone is an anthracenedione that serves to interfere with DNA intercalation and damage and a Type II topoisomerase inhibitor. On the other hand, it produces negative feedback on the pituitary gland, which prevents the release of prednisone, reduced dehydroepiandrosterone (DHEA), and dehydroepiandrosterone-sulfate (DHEAS), which can be metabolized to a small amount of T. In patients who no longer respond to primary androgen ablation, symptoms, especially bone pain can be improved with low-dose prednisone and mitoxantrone in up to 30% of cases (Tannock et al., 1989).

Other attempts have also been made to assess the role of mitoxantrone in OS, but no benefit has been shown. Today, mitoxantrone is used to improve quality of life and control pain beyond secondary or tertiary treatment or CT.

When transition to **second-line hormone therapy** is inevitable in metastatic PCa (if there is disease progression despite primary hormonal therapy),different hormonal treatments are applied, such as withdrawal of antiandrogen, replacement of antiandrogen or increasing its dose, estrogen therapy, switching to progestational agents, use of glucocorticoids, or adrenal androgen synthesis inhibitors.

TREATMENTS IN CASTRATE-RESISTANT PROSTATE CANCER

Metastatic PCa becomes CRPCA by developing resistance to ADT within an average of 18-24 months. According to the guidelines, despite serum testosterone being at the castrate level (<50 ng/dl or 1.7 nmol/l), the presence of one of the following criteria is defined as CRPCA: a) biochemical progression referring to more than a 50% increase in two of three consecutive PSA measurements and PSA >2 ng/ml and b) radiological progression referring to two or more new bone lesions or soft tissue lesions in bone screening based on response evaluation criteria in solid tumors (Cornford et al., 2017).

Many mechanisms are considered to be effective in resistance development, including AR overexpression, AR hypersensitivity, AR mutation, mutations in coactivators, androgen-independent receptor activation, and AR variants (Chandrasekar et al., 2015).

Before 2018, the treatment options for non-metastasis CRPCA (nm-CRPCA) were observation, first-generation AR

antagonists, such as bicalutamide and flutamide, estrogens, or ketoconazole, but none was associated with survival benefits (Lodde et al., 22010).

The development of a new second-generation AR antagonist in recent years has altered the treatment scheme for nm-CRPCA and provided new prospects for prolonged life expectancies in patients with advanced PCa.

Apalutamide is an antiandrogen that directly binds to the ligand binding domain of AR and prevents AR translocation, DNA binding, and AR-mediated transcription (Clegg et al., 2012).

For nm-CRPCA therapy, apalutamide is an FDA-approved agent that was shown to have the benefit of non-metastatic survival in a phase III study (SPARTAN) (Smith et al., 2018).

Enzalutamide, a new-generation AR blocker approved by FDA in 2013, inhibits DHT receptors both on the target cell surface and on the nucleus. Enzalutamide shows higher affinity for AR compared to older-generation antiandrogens, such as bicalutamide and flutamide. In addition to direct AR inhibition, it reduces AR translocation in the nucleus and the binding of AR to DNA, leading to a decrease in transcriptional activity. Non-steroidal antiandrogens still allow ARs to be transferred to the nucleus, while enzalutamide blocks AR transfer, and therefore suppresses possible agonist-like activity (Tran et al., 2009).

In the PREVAIL study, a placebo was compared with enzalutamide, and OS was reported to be 32.4 months in the enzalutamide group and 30.2 months in the placebo group. Enzalutamide was statistically significantly superior in terms of radiological progression-free survival rate and time to CT, time to first skeletal event, response rates in soft tissue lesions, time to PSA progression, PSA response rates, and quality of life scores (Beer et al., 2014).

Darolutamide is a second-generation antiandrogen and a non-steroidal AR antagonist similar to enzalutamide and apalutamide. Although it differs from enzalutamide and apalutamide in structure, it causes the decrease of the growth of PCa cells (Borgman et al., 2018).

Preclinical studies have shown that darolutamide inhibits AR more strongly than other second-generation antiandrogens in a pre-clinical CRPCA model characterized by AR amplification and over-expression compared to enzalutamide. Furthermore, darolutamide has the additional ability to inhibit some mutations of AR, which occur as a result of the use of enzalutamide or apalutamide. In addition, the power of darolutamide to cross the blood-brain barrier is at a negligible level. Therefore, it theoretically causes a much lower risk of cerebral side effects than enzalutamide or apalutamide (Moilanen et al., 2015).

There is no study directly comparing enzalutamide, apalutamide and darolutamide; therefore a direct comparison between studies is not valid. However, all the results from the ARAMIS, PROSPER and SPARTAN trials provide positive results for primary endpoint metastasis survival (Smith et al., 2018; Fizazi et al., 2019; Hussain et al., 2018).

Docetaxel is a taxane derivative, and studies using it as a single agent or in combination with estramustine showed objective response rates in 38% of patients and a PSA decrease by more than half in 69% of patients (Picus et al., 2018; Berry et al., 2001).

In light of studies performed after these findings, cytotoxic CT, especially docetaxel with prednisone has been accepted to significantly prolong OS in CRPCA, and

FDA has confirmed the use of docetaxel in treatment (Tannock et al., 2004).

In another study, it was concluded that treatment with estramustine and docetaxel in CRPCA not only moderately increased survival but also had side effects, and therefore it is rarely used (Petrylak et al., 2004).

Cabazitaxel is a third-generation semi-synthetic taxane developed after PCa resistance to other taxanes was observed (Mita et al., 2009).

Cabazitaxel was found to be as strong as docetaxel in cell lines and have antitumor activity in paclitaxel and docetaxel resistant models. In a phase III study in patients with CRPCA with progressive disease after docetaxel treatment, an evaluation was performed in *mitoxantrone + prednisone* and *cabazitaxel + prednisone* groups. There was a 30% risk of death in the cabazitaxel arm compared to the mitoxantrone arm. However, cabazitaxel showed higher side effects, with the most common being neutropenia, leukopenia, and anemia (De Bono et al., 2010).

In a later study comparing 20 mg and 25 mg cabazitaxel in order to reduce side effects and evaluate their efficacy, the efficacy rates were found to be similar, and side effects were less in the 20 mg arm (De Bono et al.,2016).

As a result, cabazitaxel remains an option for CRPCA cases, in which docetaxel treatment has been unsuccessful. However, there is no data to support that it is more effective than docetaxel.

Abirateron acetate (AA) blocks cytochrome p450c17. Thus, 17-alpha-hydroxylase and 17-20-lyase enzymes are inactivated and suppress androgen synthesis. Following AA intake, it transforms into its active metabolite of abiraterone, suppressing androgen production from testicular, adrenal and tumor tissues, providing an effective androgen blockade. It should be used with prednisone/prednisolone to prevent drug-induced hyperaldosteronism. The COU-AA-302 study, investigating the efficacy of CT-naïve CRPCA patients, included asymptomatic or mildly symptomatic patients without visceral metastasis. One study arm was given *AA + prednisolone* while the other arm received *placebo + prednisolone*. Survival without radiological progression was 16.5 months in the AA group and 8.2 months in the placebo group. Furthermore, a 25% reduction was achieved in the mortality risk of AA. Since this value did not reach the predefined value, it was not accepted as significant and was interpreted as a tendency in OS in favor of AA (Ryan et al., 2013).

In patients who cannot tolerate docetaxel treatment, the use of AA may be an appropriate approach. In addition, the use of AA in the asymptomatic or minimal symptomatic period before the deterioration of patient performance provides more advantages compared to its use in the advanced symptomatic period. However, Schweizer et al. reported that the use of AA before docetaxel in CRPCA led to the inhibition of AR pathways by taxanes and the formation of cross-resistance and limited antitumor activity (Schweizer et al., 2014; Van Soest et al., 2013).

Radium-223(Ra-223) is a calcimimetic agent and causes DNA breaks with α-particles it emits by forming complexes with hydroxyapatite in bone mineral tissue. Ra-223 is the only bone-specific treatment with confirmed efficacy demonstrated by a phase III study (ALSYMCA) published in 2013 (Parker et al., 2013).

This study included CRPCA patients with two or more bone metastases but no visceral metastasis, who had an ECOG performance score of 0-2, who had disease progression after docetaxel, or were not suitable for docetaxel treatment. Patients were randomized to the Ra-223 and placebo arms. Meanwhile, patients continued their

standard treatment. OS was 14.9 months in the Ra-223 treatment group and 11.3 months in the placebo group. Concerning all the results, Ra-223 was significantly superior to the placebo in terms of the time to first skeletal event, time to alkaline phosphatase increase, and time to PSA increase. In addition, it was determined that Ra-223 treatment positively affected OS and was found to be safe in both the group that had used docetaxel and the group that had not previously received this treatment (Hoskin et al., 2014).

In another study comparing the activity of AA and AA + Ra-223, it was determined that OS did not increase and skeletal events were at a higher rate in the combination arm, and the authors emphasized that these two agents should not be used together (Smith et al., 2019).

Zoledronate is a bisphosphonate effective in bone metastases and pain relief in patients with CRPCA. In vitro and in vivo models revealed that it also has antitumor activity, which prevents apoptosis, tumor cell growth, adhesion, invasion, and angenesis, extending beyond its antiosteoclastic activity. Studies have also investigated the possible synergistic activity of zoledronate when combined with CT regimens in various tumors, especially PCa. More positive results have been obtained in metastatic CRPCA cases, in which zoledronate was administered metronomically after docetaxel. Thus, there is a growing interest in combining zoledronic acid with various therapeutic agents in PCa in larger studies **(**Finianos et.al.,2019)

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Proceeding Article

The Effects of Green Table Olive Processing Methods on Polyphenol Content of Some Turkish Table Olive Varieties

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Abstract

In this manuscript, some olive varieties having an importance for the Turkish table olive sector such as Ayvalik and Domat variety olives are analyzed in order to determine the types and the amounts of the phenolic compounds of which potential antioxidant activities are extremely high. The effects of the processing techniques on the phenolic compounds belonging to Turkish table olive varieties are found statistically significant in the level of p>0,01. It is determined that the amount of phenolic compounds decreases particularly in the processing of split olive due to the diffusion of phenolic compounds into the brine as well as in the processes of olives with due to the use of caustic, that increases the hydrolysis of polyphenols and diffusion, in order to remove the bitterness of olives.

Keywords: Table olive, Phenolic compounds, Total phenol, Processing, HPLC

Introduction

Olive is considered as a different kind of fruit with its low sugar content, high levels of oil content and specific bitter taste (Mafra et al., 2006). One of the three main characteristics that makes the olive fruit different from the other fruits is that olive contains sugar in the amounts of 2-6% and oil in the amounts of 20-35%, whereas the other fruits contain higher levels of sugar such as 12% and lower levels of oil such as 1-2%. Another characteristic that separates olive from the other fruits is oleuropein, which is a glucosidic matter giving the specific bitter taste to olive.

The pulp fraction of olive consists of flavonoids, secoiridoids and phenolic compounds having simple phenol structure such as C2-C6 in the amounts of 1-3% (Marsilio et al., 2001). Oleuropein is the first defined matter among these compounds (Brenes et al.,1992). Oleuropein, which is the most bioactive compound of olive, consists of three main structures such as a polyphenol, 4-(2-hydroxyethyl)benzene-1,2 diol that is also known as hydroxytyrosol; a secoiridoid known as elenolic acid and a glucose molecule. Oleuropein constitutes an importance also for human health due to its antiatherogenic, anticanserogenic, anti-inflammatory and antimicrobial effects (Gikas et al., 2007; Rivas et al., 2000).

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Although many studies have been carried out related to the olive oil, the phenolic properties of the olive fruit have not been completely described in Turkey yet. The complexity of the structure, the existence of numerous varieties, the differences between maturation degrees of the varieties, and the factors related to geography, variety, process and agronomy result in difficulties in describing the phenolic properties of olive (Savarase et al., 2007). Table olives and olive oil are assumed as one of the most precious sources of the "functional foods" with the phenolic antioxidant compounds they contain (Garcia et al., 2000 ; Marsilio et al., 2001).

Free radicals, which are compounds with high activity and naturally existing in human body, increase in cases such as smoking and exposing to radiation. It is reported that these radicals initiate the coronary heart diseases and cancer via damaging lipids, proteins and DNA, whereas the phenolic compounds represent an effect on decreasing the risk of coronary heart diseases via strengthen the LDL (Low Density Lipoprotein) proteins against oxidation (Gaulejag et al., 1999; Romani et al.,1999; Visioli and Galli, 1994; Romero et al., 2004; Sousa et al., 2006; Boskou et al., 2006).

In addition to their antioxidant properties, phenolic compounds are the constituents that primarily affect the quality parameters due to their contribution to shelf-life, taste, flavour, colour; creating the sensory characterization depending on the formation of taste in table olives an olive oil; increasing the stability against otooxidation (Bianco and Uccella,2000; Garcia et al.,2000; Kalua et al.,2005; Savarase et al., 2007).

In several studies, it is stated that process techniques and the systems are assumed as the major factors affecting the types and the amounts of the phenolic compounds in olive as well as the variety and the maturity of olive (Ryan et al., 1999).

Each country has their own traditional methods for the consumption of olive in addition to the industrial production methods aimed at market. In Turkey, traditional methods used for the productions of green split and cracked olive, dry-salted olive, turning olive and olive in brine as well as the industrial processing techniques used for the productions of treated black olives, olives darkened by oxidation, Spanish style green olives, natural turning color olives and stuffed olives are applied properly for the world trade.

In Turkey, some of the olives used for the production technology of table olives are mostly produced for the purpose of table consumption (Gemlik, Domat and Uslu variety olives etc.), whereas some of the olives are evaluated in the sector for oil production (Ayvalik, Memecik variety olives etc.). Ayvalik variety olive is generally processed into green cracked and split, and turning color split olive; Domat variety olive is used for the productions of green cracked and split olive, Spanish style green olive and stuffed olives.

Researchers point out that the studies carried out in order to determine the quality characteristics of food products should not only focus on the characteristics of the final product, but also focus on the composition, texture, taste and the flavour of the raw materials. Recently, consumers are known to be more critical towards the modern production processes and thus the demand for the natural, un-processed foods and for the food products without additives increases. It is observed that the organic food products and the food products without additives, which are assumed as more reliable, tastier and more natural, are mostly preferred rather than the food products produced as a result of mass production in industrial scale. For this reason, hedonistic and functional subjects become more prominent for the qualification of nutritional value (Bianco and Uccella, 2000).

This study has an importance due to lack of the detailed studies related to the

subject in Turkey, although olive is a significant source of phenolic compounds and the phenolic compounds are effective matters on human health with their antioxidant activity. It is aimed to determine the phenolic profiles of some major olive varieties used for the purpose of green table olive consumption, in addition to provide the varieties rich in biophenols to be cultured widely. Furthermore, it is believed that the study contribute to the determination of the methods that have less effects on the decrease of phenolic capacity during the production of table olives. Thus, it is aimed at providing these methods to be applied widely and providing consumers to reach more qualified and healthy products after obtaining an increase in the quality characteristics of the products via the application of the mentioned methods.

Material and Methods

Materials

In this study, Ayvalik and Domat variety olives harvested from the collection plant of Bornova Olive Research Institute were used. For each processing collected about 240 kg olives and put into two containers. Then, three sample analyzed in three replicate.

The harvest times for the olive varieties were determined according to the specific process techniques stated in Turkish Food Codex. Domat olives were harvested in the first week of October, whilst Ayvalik were harvested in the third week of October.

Processing olives

Processing green split olives

Domat and Ayvalik olives were harvested in the period of green-yellow and sized; then they were washed and taken into the polyester tanks after they were split. They were stored in brine consist of 2% NaCl and 0.2% citric acid during 4-6 weeks changing the solution per week. After the bitter taste was removed, olives were stored in brine consist of 8% NaCl and 1% citric or lactic acid.

Processing Spanish-style green olives

Domat olives were harvested in green-yellow maturity and then separated according to their size. The process consisted of treating the olives with 1,8 g/100 mL NaOH solutions for Domat olives until the alkali reached 2/3 of the flesh. Then the fruits were washed with tap water for 24 h, brined in a 8 g/100 mL NaCl solution, and left to follow spontaneous fermentation. The acidity level of the olives was balanced at 0,3% the addition of lactic acid. The acidity level of the olives was 0,9-1,2% at the end of the fermentation.

Chemicals

The chemicals used in the project were obtained from “Merck” as LC grade. Standards, Hydroxytyrosol (HTY) was obtained from “Extrasynthese” (France), Gallic acid (GA), Tyrosol (TY), Chlorogenic acid (CHL), Vanillic acid (VA), Caffeic acid (CA), Syringic acid (SYA), p-Coumaric acid (CO), Ferulic acid (FA), Cinnamic acid (CIN), Quercetin (QUE), Luteolin (LUT), and Apigenin (API) were kindly obtained from “Sigma” (USA).

Extraction and determination of table olives phenolic compounds by HPLC

For the extraction of phenolic compounds, 5 grams of sample was centrifuged at 4000 rpm for 20 minutes with (80:20) % methanol: water (400ppm Sodium metabisulfite). The applications were repeated for 3 times. The collected methanol phases were evaporated at 35°C in rotary evaporator. Extraction with n-hexane and ethyl acetate was carried out for 3 times. The collected ethyl acetate phase was evaporated at 35°C in rotary evaporator. After it was solved with 2.5 ml methanol and filtrated through 0.45 µm, the sample was injected to 20 µl liquid chromatography device for the measurements (Morello et al., 2005).

In order to be able to determine the phenolic compounds analysis, we used a high performance liquid chromatography

(HPLC) system. It is an Agilent HP 1100 series, equipped with a vacuum degasser, a gradient pump, diode array UV detector (280 nm) and Phenomenex C18 RP (250mm x 4,6mm, 5µm) column. The temperature of the column was at ambient temperature. The injection volume was 20 µl, and elution was performed at a flow rate of 0,9 ml/min, using a mixture of formic acid 5% (solvent A) and methanol (solvent B) as mobile phases. The gradient elution program was changed as follows: to 98% (A) and (2%) for 3 min, 95% (A) and 5% (B) in 2 min, 90% (A) and 10% (B) in 5 min, 85% (A) and 15% (B) in 5 min, 80% (A) and 20% (B) in 15 min, 75% (A) and 25% (B) in 6 min, 65% (A) and 35% (B) in 3 min, 60% (A) and 40% (B) in 4 min, 55% (A) and 45% (B) in 6 min, 53% (A) and 47% (B) in 3 min, 50% (A) and 50% (B) in 17 min, 33% (A) and 67% (B) in 4 min and 100% solvent B in maintained for 10 min. Phenolic compounds were identified by comparing their retention times with those of commercial standards The registration of spectra by an identification test is facilitated by the use of a photodiode receiver detector. Detection was done at 200 and 400 nm.

Statistical analysis

In this project, three extractions of each sample were done and the extracts were analysed three times by HPLC. After applying variance analyses, the data were evaluated via Duncan's new multiple range test to different table olive methods (raw material, turning color split and Spanish style green).

RESULTS AND DISCUSSION

Phenolic Compounds in Olive Varieties

As a result of the HPLC analyses carried out on raw and the processed olive samples belonging to Ayvalik and Domat variety olives in order to determine the phenolic profile and the amounts. About thirteen phenolic compounds were established in olive varieties. These phenolic compounds are analyzed; hydroxytyrosol, tyrosol, gallic acid, chlorogenic acid, vanillic acid, caffeic acid, syringic acid, p-coumaric acid, ferulic acid, cinnamic acid, quercetin, luteolin, and apigenin. The standard chromatograms belonging to the analyzed phenolic compounds are depicted in Fig.1.

Phenolic Compounds Determined in Raw Olives

All the phenolic componds were identified in raw olive samples except for gallic acid and syringic acid. Chlorogenic acid was only determined in the raw olives. Gallic acid and syringic acid weren't found anyone olive samples. Also, while hydroxytyrosol, tyrosol, chlorogenic acid, caffeic acid and apigenin were determined as major phenolics in Ayvalik olive fruits, hydroxytyrosol, tyrosol, quercetin, caffeic acid, vanilic acid and ferulic acid were found as major phenolic compounds in Domat olive fruits. Concentrations, expressed as mg/100g of fresh weight, of the major biophenolic compounds found in the Ayvalik and Domat olive varieties studied at different table olive processing styles are reported in Table 1.

HTY quantity of Domat variety olive was found to be more rich according to Ayvalik variety olive. The values belonging to Domat and Ayvalik olives were found respectively as 55.61 and 42.46 mg/100g (Table 1).

Verdeal Transmontana (752 mg/kg) and Madural (830 mg/kg) variety olives in Porteguese presented higher HTY amounts (Sousa et al.2015). Levels of HTY are not consistent in the literature, ranging from 0.2 to ~71 g/kg (dw) (Charoenprasert and Mitchell, 2012). Concentration of HTY was determined as 57 mg/100g in the Intosso cultivar (Marsilio et al.2001). Also, Melliou et al.(2015) reported that HTY content (89,4 mg/100g) were measured in fresh olives (wet weight). HTY content was determined between from 18,9 to 89,18 mg/100g in Gemlik variety olives (Uylaser, 2015). HTY concentrations in our study were found similar or closely with other studies.

Domat had the highest amount of tyrosol demonstrating a significant difference with 11.21 mg/100g, whereas Ayvalik were determined as the samples having the lowest amount of tyrosol with 6.13 mg/100g.

Tyrosol content was found as 40 mg/100g in the Intosso cultivar by Marsilio et al.(2001). The results of the present study are in good agreement with the findings of Marsilio et al. (2001) who observed a decline in phenolic compound content with fresh olive. Also, Dagdelen et al.(2013) determined tyrosol concentration more in Domat olives according to Ayvalik olives. We have found lower values in our study than in other studies. It is seen that the phenolic constituents change according to the varieties.

The amount of luteolin in Domat olive was determined as 2.27 mg/100g whereas in Ayvalik olive was found as 3.66 mg/100g. Luteolin was determined in Cobrancosa variety about 7,5 mg/kg (Malheiro et al.,2011). Sousa et al. (2015) stated that luteolin characterized mainly Verdeal Transmontana olives from the third and fourth (10th Nov.) sampling dates, due to higher content on this flavone.

In terms of apigenin, the highest value was determined in Ayvalik olives with 7.54 mg/100g; whereas lower amounts of apigenin were found in Domat olive as 3.64 mg/100g. Apigenin was the most abundant phenolic compound in Ayvalik olives after HTY. Due to the amount of apigenin, it can be separated from other olives. Thus, apigenin may be evaluated as a characteristic property for these olive varieties. Vanillic acid (3 mg/100g) and flavanoid content (Luteolin-7-O-glucoside – 2 mg/100g) were low in fresh olives (Marsilio et al.2001).

Chlorogenic acid, vanillic acid, caffeic acid, p-coumaric acid, ferulic acid, cinnamic acid and quercetin contents were determined between 5,9 and 2,13 mg/100g. Phenolic acids such as p-coumaric acid, chlorogenic acid, vanillic acid, syringic, ferulic, and homovanillic acid, and caffeic acid are also present in pulp, and their levels are generally in the milligram per kilogram range (Charoenprasert and Mitchell, 2012). Also, chlorogenic acid was identified varying between 6,1 and 1,2 mg/100g in Portuguese olive cultivars (Sousa et al.2015).

Gallic and syringic acids were not determined in the raw olive samples. Also, Sousa et al. (2006) couldn't detect syringic and vanillic acids in 5 olive varieties of Porteguese.

The differences in terms of the types and the compositions of the phenolic compounds that the raw samples of the olive varieties contain were found statistically significant in the level of $p<0.01$. These significant differences could be explained by the cultivated variety and the specific processes applied on the fruits.

Pereira et al. (2006) informed that such changes on both quantitative and qualitative fractions of phenolic compounds in the studied table olives are related to olive cultivar. The phenolic composition of olives is very complex and depends upon many factors such as fruit maturation stage, part of the fruit (e.g., pulp or seed), cultivar, and season**.** There are considerable differences in the levels of these phenolics among cultivars (Charoenprasert and Mitchell, 2012).

Hydroxytyrosol, tyrosol, and their glycosidic forms are the predominant phenolic alcohols in olive pulp. Flavonoids and phenolic acids are present at low concentration (usually <100 mg/kg dry weight) and include luteolin-7-glucoside, rutin, apigenin-7-glucoside, luteolin-4-glucoside, luteolin-7-rutinoside, and quercetin-3-rhamnoside (Charoenprasert and Mitchell, 2012). According to the results of other study, the highest levels of hydroxytyrosol (253.67 mg/kg), vanillic acid (30.98 mg/kg), tyrosol (28.70 mg/kg), syringic acid (3.28 mg/kg), p-coumaric acid (2.94 mg/kg), ferulic acid (0.85 mg/kg) and cinnamic acid (0.21 mg/kg) were determined in the fresh Gemlik variety olives (Uylaser, 2015).

The Amounts of the Phenolic Compounds Determined According to the Olive Varieties

Phenolic Profiles of Ayvalik Variety Split Olives

In international olive council table olives preparing methods, ‘‘split olives’’ are known that whole olives are splitted lengthwise by cutting into the skin and part of the flesh. HTY, luteolin and apigenin contents were found higher in the olive samples that had been processed with split olive technique than the raw olive samples had (Table 1).

During the fermentation period, the HTY amount showed a constant increasing trend after 180 days. HTY compound is considered a marker to determine the oleuropein degradation and the diffusion of phenols from drupes to brine (Randazzo et al., 2011). The increase observed in the HTY content may be explained with the decomposition of oleuropein during the fermentation period and as a result of that creating HTY. Several researchers also support the approach of the increase in the amount of HTY as a result of oleuropein decomposition during the fermentation period. Thus, it is assumed as an expected result (Esti et al.1998 ; Gikas et al.2007; Marsilio et al.2001; Morello et al.2005a ; Rivas et al.2000). Similarly, the concentration of the simple phenol HTY increased during fermentation due to the increased activity of some hydrolytic enzymes.

HTY, luteolin and apigenin content which demonstrated increase with the application of process technique. It is considered that the increase observed in the amount of luteolin was due to the hydrolysis reactions occured on phenolic compounds during the production processes. In some references, it is pointed out that the amount of luteolin demonstrated an increase during the maturation period. Furthermore, it is stated that the increase in the amount of luteolin should be regarded as a determination criterion for the maturation level.

HTY was the main simple phenolic compound identified in all brines, its proportion was up to 84% of total simple phenolic compounds. Actually, this finding is in a good agreement with the literatüre data where HTY was found to be the most abundant phenol in green table olives. This compound results from the hydrolysis of oleuropein, which is the major phenolic in fresh green olive fruit (Kiai and Hafidi, 2014**)**. During fermentation, HTY was 25 mg/L after 15 days, and it became 155 mg/L after 270 days (Poiana and Romeo, 2006).

Chlorogenic acid content was determined as 5.9 mg/100g in the processed olive samples. This amount is assumed as lower than the limit levels that might be determined in processed samples. For this reason, this data is leading to the consideration of the loss of chlorogenic acid during the fermentation period.

The phenolic compounds that are absent in the raw and processed samples of Ayvalik olives were determined as syringic acid and gallic acid. The absence of these acids in Ayvalik olive variety may be regarded as an important criterion in evaluating the phenolic profile of this olive variety. In case this result is supported by the further studies, the absence of syringic acid and gallic acid in Ayvalik variety may be approved as one of the typical characteristics of this variety.

A decrease with the application of process techniques was observed in the amounts of the other phenolic compounds such as tyrosol, vanillic acid, caffeic acid, p-coumaric acid, ferulic acid, cinnamic acid and quercetin. Chlorogenic acid, vanillic acid and p-cumaric acid contents of Ayvalık fruits were established as 4.05, 4.74 and 3.92 mg/kg, respectively (Dagdelen et al. (2013). Our values has found more according to Dagdelen et al. (2013). This differences may be due to fruit maturation stage, part of the fruit and agronomic conditions (climate, fertilization etc.).

During storage in brine, in our study, the amount of tyrosol has decreased while it increased in the study of Marsilio et al.

(2001). Brenes-Balbuena et al. (1992) reported caffeic acid as the product of verbascoside degradation which appeared after fermentation in all types of olives. p-Coumaric acid can be diffused moderately into the brine due to its low solubility.

As Sousa et al. (2006) reported that the cracked olives underwent more losses during the washing and debittering stages. During removal of bitterness, characteristic of green olives, the loss of hydrossoluble compounds is unavoidable. The cultivar phenolic amount is, therefore, of majör importance for the residual amounts of phenolics in processed ‘‘splitting’’.

Pistarino et al.(2013) stated that more than 75% of phenolic compounds were reduced in the olive pulps after 100th days of the fermentation.

Phenolic Compounds of Domat Variety Split Olives and Spanish Style Green Olives

As it was observed in the results of Ayvalik olives, HTY content demonstrated an increase during the fermentation period in the split samples (61.16 mg/100g) and the samples with caustic (84.07 mg/100g) when compared to the raw olive samples (55.61 mg/100g) that belong to the Domat variety as well (Table 1).

The studies carried out also indicated that HTY content increased in the olive samples processed with caustic as a result of the hydrolysis of oleuropein (Kiai and Hafidi, 2014; Marsilio et al.2001). It was determined that although HTY was a water-soluble matter, it could still exist in the composition of olive in high amounts. This compound results from the hydrolysis of oleuropein, which is the major phenolic in fresh green olive fruit. Moreover, an increase of HTY content in brine during the brining process is reported due to its diffusion from the olives into the brine and also because of the acid hydrolysis of oleuropein, and phenols that decreased during the brining process (Romero et al., 2004). Thus, at the end of processing, HTY become the main phenol in brine (Kiai and Hafidi, 2014).

As well as the samples processed with caustic, HTY content increased due to the hydrolysis of oleuropein in split-type olive samples; whilst it is also estimated that some part of HTY diffusion into the brine due to its water-soluble characteristic (Morello et al., 2005).

Luteolin and apigenin contents were found higher in the samples that the splitting process was applied in comparison to the raw samples, whereas lower amounts were determined in the samples processed with caustic (Table 1). As well as in the Ayvalik samples processed via splitting technique, the increase in the amounts of luteolin and apigenin in split samples and the decrease in samples processed with caustic were found to be related to the processing techniques in Domat variety.

A decrease was observed in the values of tyrosol and caffeic acid existing in both of the processed olive samples in comparison to the raw olive samples. The Amounts of the other phenolics such as vanillic acid, p-coumaric acid, ferulic acid, cinnamic acid and quercetin demonstrated decrease in the samples processed with splitting technique, whilst none of the mentioned phenolics were found in the sample group processed with caustic. Vanillic acid, p-coumaric acid, ferulic acid, cinnamic acid and quercetin weren’t identified in the Spanish style table olives. Dağdelen et al.(2013) stated that HTY, oleuropein, tyrosol, vanilic acid, rutin, luteolin and p-cumaric acid were determined as major phenolics in Domat olive fruits.

It was determined that Domat type raw samples contained 2.38 mg/100g of chlorogenic acid. However, it was found out that chlorogenic acid content in both of the processed Domat olive samples were below the limit levels. Thus, it is considered that chlorogenic acid content decreased during the fermentation period.

Considering the absence of the phenolic compounds such as syringic acid

and gallic acid in raw and the processed samples belonging to Domat variety, it may be indicated that this data would be a significant parameter in determining the phenolic profile of Domat type olives.

In another study, antioxidant capacity of table olives was evaluated according to processing techniques. Processing methods were showed significant differences. The average antioxidant capacity of processed olives was in the following order; untreated black olives in brine > Californian style black olives > untreated black olives in dry salt > Spanish style green olives (Sahan et al.2013). It is revealed that the Spanish style process causes significant loss of phenolic compounds.

4. Conclusion

In this study, the phenolic properties of Ayvalik and Domat olive varieties that have a huge field of production and an industrial value in Turkey were determined. In addition, the effects of the processing techniques applied in order to make these olives available as table olives on the phenolic compound were also determined. As a result, the effect of the processing techniques on the amounts and the characteristics of the phenolic compounds of the table olive samples were found statistically significant in the level of $p > 0.01$. These significant differences could be explained by the cultivated variety and the specific processes applied on the fruits, especially the use of brine or lye.

Hydroxytyrosol, tyrosol, apigenin and luteolin were identified for Ayvalık and Domat at the raw and processed olives. Both of the olive varieties were generally found to be rich in the phenolic compounds such as hyrdoxytyrosol, tyrosol, luteolin and apigenin.

Split-type olive processing caused a diffusion of the phenolic compounds to the brine due to the split existing on the olive sample. Moreover, the usage of lye solution in the process techniques and the processing of olives with NaCl in order to remove the bitter taste of the olives caused a diffusion and hydrolysis of polyphenols. Thus, particularly these mentioned olive processing techniques were found to be affective on decreasing the amounts of the phenolic compounds in olive samples.

Malheiro et al.(2011) also reported that individual amounts of phenolic compounds are significantly affected ($P < 0.001$), with the exception of quercetin, by the olive cultivar used for table olive processing, and among the phenolic compounds identified, the most abundant were hydroxytyrosol, tyrosol and verbascoside.

Melliou et al.(2015) indicated that the rightness of the consumers in tending to prefer mostly natural food products in recent days was underlined once again in their study. Our study also support this findings. The significance of the amount of the determined phenolic compounds existing in olive samples proved the necessity of olive to take more place in tables.

The information presented in this investigation shows variation in the composition of a range of key phenolic compounds in olives that is dependent upon both the variety and processing method used to create the olive product, and these effects must be considered when developing possible health claims for table olives and their products.

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TABLES

Table 1. Amounts of phenolic compounds of raw and processed olive samples

FIGURE CAPTIONS

Fig.1. Standard Material Chromatogram Belonging to the Phenolic Compounds
(Phenolic compounds: 1;Gallic acid, 2:Hydroxytyrosol, 3: Tyrosol, 4:Chlorogenic acid, 5:Vanillic acid, 6:Caffeic acid, 7: Syringic acid, 8:p-Coumaric acid, 9:Ferulic acid, 10:Cinnamic acid, 11:Quercetin, 12: Luteolin, 13:Apigenin)

Fig.2 Phenolic Profiles in the Raw Olive Samples of Ayvalik Variety
(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Chlorogenic acid, 4:Vanillic acid, 5:Caffeic acid, 6:p-Coumaric acid, 7:Ferulic acid, 8:Cinnamic acid, 9:Quercetin, 10: Luteolin, 11:Apigenin)

Fig.3 Phenolic Profiles in the Turning Colour Split Olive Samples of Ayvalik Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3: Vanillic acid, 4:Caffeic acid, 5:p-Coumaric acid, 6:Ferulic acid, 7:Cinnamic acid, 8:Quercetin, 9: Luteolin, 10:Apigenin)

Fig.4 Phenolic Profiles in the Raw Olive Samples of Domat Variety
(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Chlorogenic acid, 4: Vanillic acid, 5:Caffeic acid, 6:p-Coumaric acid, 7:Ferulic acid, 8:Cinnamic acid, 9:Quercetin, 10: Luteolin, 11:Apigenin)

Fig.5 Phenolic Profiles in the Split Olive Samples of Domat Variety
(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3: Vanillic acid, 4:Caffeic acid, 5:p-Coumaric acid, 6:Ferulic acid, 7:Cinnamic acid, 8: Luteolin, 9:Apigenin)

Fig.6 Phenolic Profiles in the Spanish Style Olive Samples of Domat Variety
(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Caffeic acid, 4: Luteolin, 5:Apigenin)

Table1. Amounts of phenolic compounds of raw and processed olive samples (mg/100g).

	Ayvalık		**Domat**		
	Raw	**Split**	**Raw**	**Split**	**Spanish style**
Gallic acid	ND	ND	ND	ND	ND
Hidroxytyrosol	42,46 ± 0,342	87,6 ± 0,247	55,61 ± 0,154	61,16 ± 0,028	84,07 ± 0,55
Tyrsol	6,13 ± 0,027	4,68 ± 0,036	11,21 ± 0,304	2,74 ± 0,031	1,15 ± 0,028
Chlorogenic acid	5,9 ± 0,031	ND	2,38 ± 0,012	ND	ND
Vanilic acid	3,13 ± 0,014	0,75 ± 0,021	6,55 ± 0,023	2,38 ± 0,025	ND
Caffeic acid	4,25 ± 0,025	0,12 ± 0,034	7,14 ± 0,026	3,71 ± 0,028	1,77 ± 0,044
Şyringic acid	ND	ND	ND	ND	ND
p-Coumaric acid	3,19 ± 0,042	1,03 ± 0,048	3,47 ± 0,034	1,19 ± 0,047	ND
Ferulic acid	3,85 ± 0,038	0,25 ± 0,014	4,41 ± 0,028	1,63 ± 0,038	ND
Sinnamic acid	2,13 ± 0,036	0,41 ± 0,018	2,74 ± 0,016	0,43 ± 0,023	ND
Quercetin	3,74 ± 0,022	1,86 ± 0,027	7,97 ± 0,021	3,65 ± 0,023	ND
Luteolin	3,66 ± 0,063	16,7 ± 0,118	2,27 ± 0,017	6,88 ± 0,034	1,59 ± 0,029
Apigenin	7,54 ± 0,019	8,32 ± 0,043	3,64 ± 0,031	5,14 ± 0,049	2,13 ± 0,051

**ANOVA was applied for the obtained data.*

FİGURES

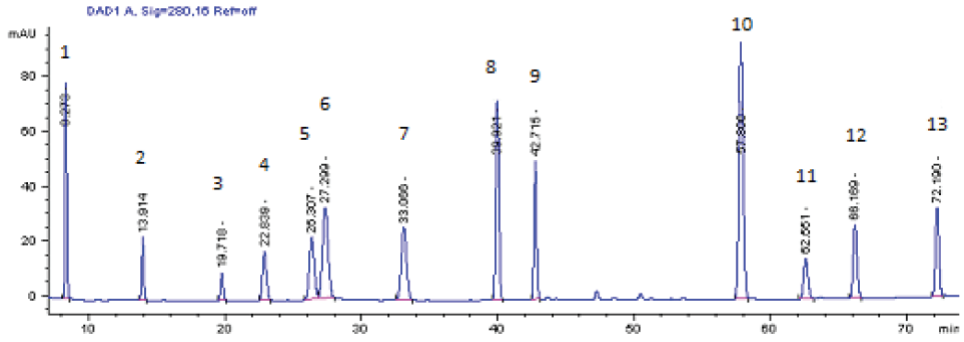

Fig.1. Standard Material Chromatogram Belonging to the Phenolic Compounds

(Phenolic compounds: 1;Gallic acid, 2:Hydroxytyrosol, 3: Tyrosol, 4:Chlorogenic acid, 5:Vanillic acid, 6:Caffeic acid, 7: Syringic acid, 8:p-Coumaric acid, 9:Ferulic acid, 10:Cinnamic acid, 11:Quercetin, 12: Luteolin, 13:Apigenin)

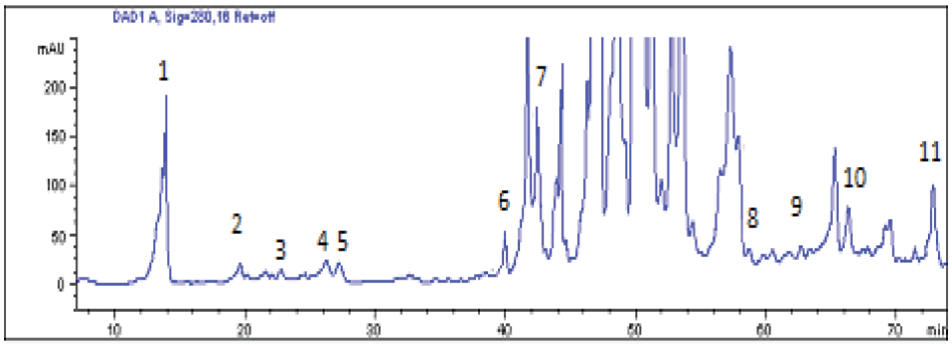

Fig.2 Phenolic Profiles in the Raw Olive Samples of Ayvalik Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Chlorogenic acid, 4:Vanillic acid, 5:Caffeic acid, 6:p-Coumaric acid, 7:Ferulic acid, 8:Cinnamic acid, 9:Quercetin, 10: Luteolin, 11:Apigenin)

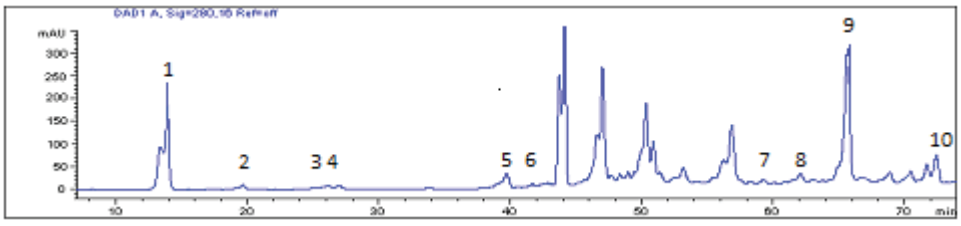

Fig.3 Phenolic Profiles in the Turning Colour Split Olive Samples of Ayvalik Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3: Vanillic acid, 4:Caffeic acid, 5:p-Coumaric acid, 6:Ferulic acid, 7:Cinnamic acid, 8:Quercetin, 9: Luteolin, 10:Apigenin)

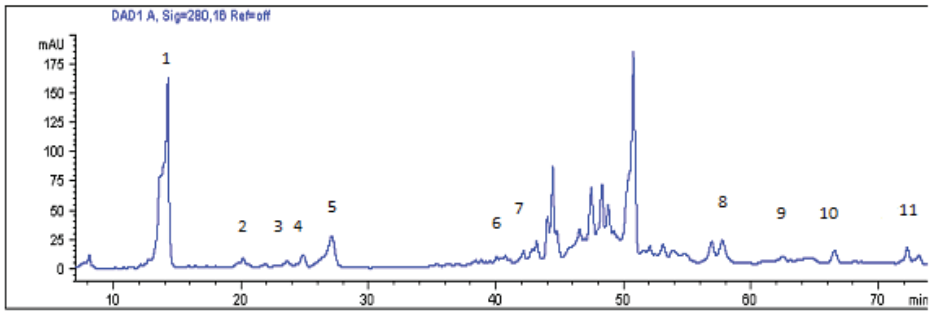

Fig.4 Phenolic Profiles in the Raw Olive Samples of Domat Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Chlorogenic acid, 4: Vanillic acid, 5:Caffeic acid, 6:p-Coumaric acid, 7:Ferulic acid, 8:Cinnamic acid, 9:Quercetin, 10: Luteolin, 11:Apigenin)

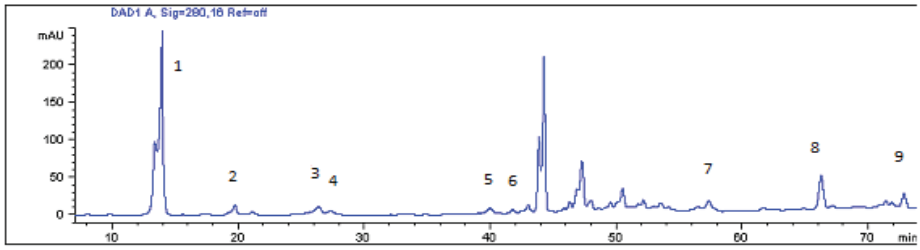

Fig.5 Phenolic Profiles in the Split Olive Samples of Domat Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3: Vanillic acid, 4:Caffeic acid, 5:p-Coumaric acid, 6:Ferulic acid, 7:Cinnamic acid, 8: Luteolin, 9:Apigenin)

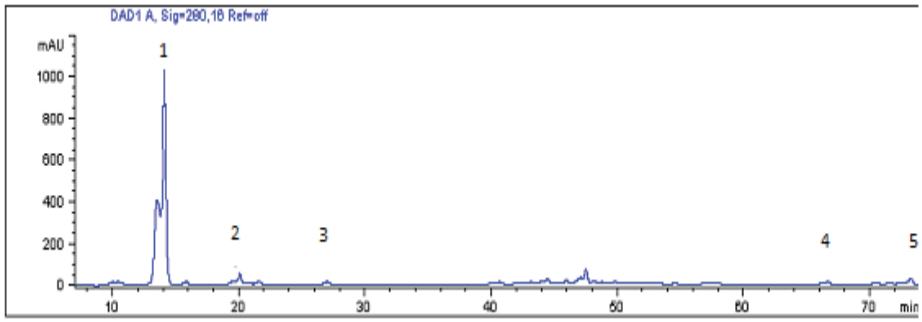

Fig.6 Phenolic Profiles in the Spanish Style Olive Samples of Domat Variety

(Phenolic compounds: 1;Hydroxytyrosol, 2: Tyrosol, 3:Caffeic acid, 4: Luteolin, 5:Apigenin)

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Proceeding Article

Cynarin, Chlorogenic and Caffeic Acid Flavonoids, Cyanidin, Peonidin Anthocyanidins in Head, Heart, Bractes of Artichokes as Antioxidative Quality Indicators: Alterations By Boiling, Steaming and Frying

Özlem TOKUŞOĞLU [1]

Abstract

In edible parts- bracte leaves, heart, head of artichoke varieties (Turkish *var*.Sakız, *var*.Bayrampaşa), proximate composition, antioxidative major phenolic acids [cyanarin-(1,3-dicaffeoylquinic acid), chlorogenic acid-(5-O-caffeoylquinic acid), caffeic acid], anthocyanidins (cyanidin, peonidin), total phenolic acids-TPA, total flavonoids-TFlav, total phenolics-TP, total antocyanins were detemined (p<0.01), the alterations on above-mentioned bioactive constituents through heat treatment effect (boiling, steaming, frying) were put forwarded. Cyanarin-(1,3-di-*O*- caffeoylquinic acid) was determined the major phenolic compound of head part of artichokes. It was determined about 6.2 ; 5.6; 3.48 fold increasing in TP content with boiling, steaming, frying, respectively respect to raw-form and total anthocyanins-TA rised as 1.93 fold with boiling whereas decreased as 1.04, 3.09 fold after steaming and frying, respectively. The important alterations were established in phenolic acids -PA, total phenolics-TP, cyanarin, chlorogenic acids in boiling (B) > steaming (S) > frying (F) towards whereas 1.36; 1.28; 2.59 fold decreasing in TFlav with B,S,F processing, respectively (p<0.01).

Keywords: Artichoke, Phenolic acid, Anthocyanin, Antioxidant, Heat treatment

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Artichoke (*Cynara cardunculus* L. *scolymus*) is an herbaceaus perennial plant belonging to Composite family (Asteraceae) and widely cultivated in the Mediterranean area and adjoining parts of Europe, which accounts for 85% of the world's production . Major producers of the globe artichoke are France, Italy, Spain, Egypt, Israel, Algeria, Morocco, and Turkey in Europe whereas California Castroville-Monterey County in USA (Tokuşoğlu, 2018& Tokuşoğlu and Başay, 2009).

Artichokes are consumed as fresh, traditional meal, and canned and are also traditionally used as a medicinal plant. The artichoke heads are edible and used worldwide. The leaves have beneficial effects against liver complaints and have strong antioxidant effects. Their leaves are brewed and consumed as teas and leaves are processed into pharmaceutical preparations such as capsules, tablets and juices. Artichokes contain bioactive compounds including phenolics which protect liver and have strong positive effects on several diseases and disorders. Also, inulin form carbohydrate in artichokes, stabilize blood sugar levels in diabetes (Tokuşoğlu & Başay,2009; Fratianni et al., 2007; Costabile et.al.2010; López-Molina et.al., 2005).

Majorly, such extracts from head and leaves of artichokes have been utilized for their hepatoprotective effects (Speroni *et. al*., 2003; Gebhardt and Fausel,1997), their benefits on the liver and their protecting against toxins and infection are important (Adzet et.al.,1987). Artichoke head and leaves have antioxidative (Miccadei et.al,2008; Gebhardt and Fausel,1997), anticarcinogenic (Agarwal andMukhtar,1996)and hypocholesterolemic activity (Rondanelli et al.,2012). The artichoke has strong choleretic activity (promotes bile secretion in the liver), and choleretics increase the excretion of cholesterol and decrease the manufacture of cholesterol in the liver (Bundy et.al.,2008). It is shown that artichoke leaf consuming improved the dyspeptic symptoms who suffer dyspepsia (digestive problems) and artichoke leaf extract has potential value in relieving irritable bowel syndrome symptoms (Bundy et.al.,2004).

These strong effects are attributed to the high polyphenolic content of artichokes including phenolic acids, majorly hydroxycinnamic acids, flavones and anthocyanins (Figure 1.) Artichoke have high proportion of phenolics (Fratianni et al., 2007; Llorach et al., 2002). The phenolics include cynarin (1,3-di-O-caffeoylquinic acid), luteolin, cynaroside (luteolin-7-*O*-glucoside), scolymoside (luteolin-7-*O*-rutinoside); phenolic acids such as caffeic, coumaric, hydroxycinnamic, ferulic, caffeoylquinic acid derivatives; mono- and dicaffeoylquinic acids, including chlorogenic; acid alcohols; flavonoid glycosides, among others (Tokuşoğlu & Başay,2009,2008; Fratianni et al.,2007; Sa´nchez Rabaneda et al., 2003).

Especially, the pleasant bitter taste of the artichoke is due mostly to a plant chemical called cynarin (1,5-dicaffeoylquinic acid), which is found in highest concentration in the leaves of the plant. It is known that extracts including cynarin have positive effects on liver health, hepatobiliary diseases, hyperlipidaemia and cholesterol metabolism (Tokuşoğlu & Başay,2009, Fratianni et al.,2007). Figure 2 shows two major compounds in globe artichoke are chlorogenic acid (5-dicaffeoylquinic acid) and cyanarin (1,5-dicaffeoylquinic acid), phenolic compounds that are derivatives of caffeic acid (Figure 2).

Anthocyanin pigments are responsible for most of the blue-purple and reddy colour intermediate hues of artichoke plant tissues and an increase in anthocyanin pigmentation is considered a positive attribute of plant. It is reported that the main major anthocyanins in artichoke heads were

cyanidin aglycone (Figure 3) and cyanidin glycosides (cyanidin 3,5-diglucoside, cyanidin 3-O-*β*-glucoside, cyanidin 3,5-malonyldiglucoside, cyanidin 3-(3"-malonyl)glucoside, and cyanidin 3-(6"-malonyl) glucoside (Schütz et.al.,2006). Besides peonidin aglycon (Figure 3) and the two peonidin derivatives were identified as peonidin 3-O-*β*-glucoside, peonidin 3-(6"-malonyl) glycoside (Schütz et.al.,2006).

Currently, the data of vegetable composition includes are mainly determined regarding raw vegetable material. The limited data are reporting on cooking processes of vegetables. Cooking processes would bring about a number of changes in the chemical composition, antioxidant activities and physical properties and vegetables (Miglio et.al.,2008; Turkmen et.al.,2005; Zhang et.al.,2004; Sahlin et.al.,2004).

It is reported that there are only two studies concerning quality parameters and antioxidant activity of some cooked vegetables including artichoke (Pellegrini et.al.,2009; Jiménez-Monreal et.al.,2009) and only one study regarding antioxidant profiles and some physical properties of artichoke (Ferracane et.al.,2008) in the literature.

The present detailed study was undertaken to determine the antioxidant activity, total phenolics, the simultaneous quantitative determination of majör flavonoids cynarin (1,5-dicaffeoylquinic acid), chlorogenic acid (5-dicaffeoylquinic acid) and caffeic acids and major anthocyanidins (cyanidin, peonidin) and major quality parameters; to investigate the influences of several heat treatments including boiling, steaming and frying on these major phenolic acids (cynarin,chlorogenic acid, caffeic acid), anthocyanidin phenolics (cyanidin, peonidin), antioxidant activity, total phenolics, and some quality indicators in head and bracte leaves of breaded artichoke varieties [*Cynara Cardunculus* L. *Scolymus* var. Sakız, BayramPaşa] and to carry out the ratio of monitored phenolics in total phenolics of raw and cooked artichokes.

2.Material and Methods

2.1.Research Material

The artichoke variety SAKIZ (Figure 4a.) was obtained from Çeşme-Karaburun via Ege University Horticultural Department, Agriculture Faculty, Izmir,Turkey. Artichoke variety BAYRAMPAŞA (Figure 4b.) was obtained from Atatürk Horticulture Institute, Yalova, Turkey.

For variety development using the clonal selection of the artichokes lineages, 2 developmental lineages and 2 control lineages were used. The material reproduction operations that were performed for the variety development experiment were set up in a randomised complete block design with 4 replications in 2 locations. In each plot containing 10 plants, 4 candidate varieties and 2 control varieties were used. Each of the experimental and the control plants had the stem weight, width, and the length, as well as the head weight, width, and height measured both at the beginning and at the end of the breeding experiment.

2.2.Chemicals

Cynarin (1,5-Di-caffeoylquinic acid) *(Cat.No:30964-13-7; 10 mg)* from Carl Roth GmbH & Co. (Karlsruhe, Germany), chlorogenic acid (5-*O*-Caffeoylquinic acid) *(Cat.No:327-97-9; 1 g)* and caffeic acid *(Cat.No.331-39-5; 1 g)* from Sigma (Germany), cyanidin *(Cat.No:528-58-5; 10 mg)* and peonidin *(Cat.No:134-01-0; 5 mg)* from Extrasynthese,Genay (France). Cyanidin-3-*O*-glycoside chlorur *(Cat.No: 7084-24-4; 5 mg)* from Sigma (Germany), luteolin 7-*O*-glukozid *(Cat.No:5373-11-5; 250 mg)* from Extrasynthese, Genay (France), 1,1-diphenyl-2-picryl-hydrazyl (DPPH) *(Cat.No. D9132-1G;1g)* from Sigma-Aldrich, Chemie Gmbh (Munich, Germany) were obtained. All HPLC grade solvents were purchased from Merck (Darmstadt, Germany).

2.3.Preparation of Artichokes to Analysis and Processing

Prior to analysis and processing, artichokes were freshly transferred to laboratory (Product Chemistry and Quality Control Laboratory) at 4 1 C refrigerated conditions from breading areas and equlibrated to room temperature for about 2 h before treatments.

Artichokes were washed,cleaned and blotted by blotting paper. Out bracte leaves and rude parts were seperated, stem parts were cutted by knife which cleaned with ethanole and awns of artichokes were discarded. Rude parts in nebs of bracte leaves were cleaned. Green parts were peeled as rolling by knife and accessed to head and heart, pileous parts were discarded by spoon. To prevent the browning of peeled parts, cutted and peeled artichokes were treated with lemon-water (For lemon-water content; 2 liter (10 glass-water) water and 3 lemon were used). Seperated green parts (bracte leaves) and white parts (heads-hearts) were homogenized at blender (*Waring*) apparatus. The homogenized bracte leaves and heart parts of artichokes were dried at N_2 atmosphere. Final samples were obtained for quality analyses, phenolic

2.4.Extraction Methodology of Artichoke Phenolic Acids

Artichokes (*cynara cardunculus var. scolymus*) were extracted the method as shown below (n=2).

Leave (or heart) part of artichoke sample was weighed (20 g)

↓

Extraction with 70% ethanol and vortex during 8 min (*Nüve*, NM 110)
Evaporation (79 °C) (Heidolp, *EssLab*,Essex,UK)

↓

Acidification and pH regulation with formic acid to pH=2.4

↓

Separation of lipid fraction (LF) with *n*-hexan and obtain the unlipidic fraction (UF)

↓

Final extract
(Extract of artichoke phenolics)

↓

HPLC Analysis (20 ⌈*L*)

2.5.High Performance Liquid Chromatographic (HPLC) Analysis Methodology for Artichoke Phenolic Acids

Major artichoke phenolics cynarin, chlorogenic acid and caffeic acid were simultaneusly determined by modified isocratic HPLC based on the procedure from Sánchez-Rabaneda et.al.(2003) and Häusler et.al.(2002) and as shown below (n=2).

Column : Hypersil-ODS
[(250·4.6 mm (5⌈m) RP-18 (Luna,Phenomenex,CAL)]
Mobile Phase : Acetonitrile/ phosphate buffer (25:75) (v/v) [pH=2.4]
Detection : Fluorometric detection (254-370 nm) ((Shimadzu UV-1601)
Flow rate : 1 ml/min
Sensitivity : 0.05 A. U.F.

2.6.Extraction Methodology of Artichoke Anthocyanidins

Artichoke (*Cynara cardunculus var. scolymus*) anthocyanidins were extracted the modified method from Goncalves et.al.(2007) and Schütz et.al.(2006) and as shown below (n=2).

The pulp of leave (or heart) part of artichoke was weighed (5 g)

↓

Extraction with 60% (v/v) aqueous methanol (MeOH) (50 ml) and vortex (*Nüve*, NM 110) during 10 min under the N_2 atmosphere at 25±1 °C

↓

Filtration of extract mix with filtre paper (Whatman No. 1) (Main Extract)

↓

Prior to HPLC injection, filtration with 0.45 ⌈m Durapore syringe (Millipore Corp., Bedford, MA)

↓

Final Artichoke Anthocyanidin Extract (Extract of artichoke phenolics)

↓

HPLC Analysis (20 ⌈*L*)

2.7.High Performance Liquid Chromatographic (HPLC) Analysis Methodology for Artichoke Anthocyanidins

Major artichoke anthocyanidins cyanidin and peonidin were simultaneusly determined by modified HPLC method based on the procedure from Goncalves et.al.(2007) and as shown below (n=2).

Column : 3.9 ×150 mm NovaPak C_{18} (Waters)
Mobile Phase : Asetic acid HCOOH (%10) (A)
Methanol (%50)+ TFA (%1) (B)
Detection : UV-VIS (520 nm)
Flow rate : 0.8 ml/min
Column temp. : 40 ˚C
Sensitivity : 0.05 A. U.F.S.

2.8.Total Anthocyanin Analyses of Artichokes

Total anthocyanins of artihockes were spectrophotometrically (*Optima SP 300)* determined based on the Estia et.al.(2002) and Prior et.al. (1998) (n=2).

The pulp of leave (or heart) part of artichoke was weighed (5 g)

↓

Extraction with HCl/ distilled water/ 80% (v/v) ethanol (EtOH) mixture (1/29/70) at ice-bath during 10 min

↓

Extract was filtered

↓

Absorbances were measured at 510 and 700 nm in buffers-pH 1.0 and pH 4.5

↓

Maximum absorbance wave length of cyanidin-3-glycoside was determined as 534 nm

↓

Total anthocyanin level was calculated according to equation as shown below

$$A = (A_{510} - A_{700})_{pH1.0} - (A_{510} - A_{700})_{pH4.5}$$

↓

μg cyanidin-3-glycoside (C3G) /100 g extract was determined (MW = 445.2) (max. molar abs. εmolar, ε = 29600)

2.9.Total Phenolic Analyses of Artichokes

The level of phenolic compounds in artichoke samples was determined based on the Folin-Ciocalteu method(Singleton& Rossi,1965) and was expressed as gallic acid equivalents (n=2).

5 ml of 80% methanol including 1% HCl solution was added to 1 g artichoke leave (or heart)

↓

The solution was mixed at 4 ± 1 °C (ice-bath) during 2 h and centrifuged at 4000×*g* during 15 min.

↓

The extract was filtered and clear part was separated for phenolic analyses.

2.5 ml of clear part (supernatant) was mixed with Folin-Ciocalteu reagent (2.5 ml) + distilled water (10 ml) [in ratio 0.5/0.5/10 (v/v/v)]

↓

2 ml of 7% sodium carbonate (Na_2CO_3) was added to the mixture

↓

The mixture was incubated for 2 h at room temperature and obtained blue-violet colour solution was measured at spectrophotometer (*Optima SP 300)* at 760 nm.

↓

Total phenolics was expressed as chlorogenic acid equivalents (as μg Clg/ 100g fresh artichoke)

2.10.Total Flavonoid Analyses in Artichokes

Total flavonoid analyses of artichokes were carried out spectrophotometrically(*Optima SP 300*) based on the aluminum chlorur chlorimetry method according to Singleton et.al. (1999) (n=2).

1 g artichoke leave (or heart) puree was treated with 5% sodium nitrite ($NaNO_2$) , 10% alüminum chlorure ($AlCl_3 \cdot 6H_2O$) and 1 M sodium hydroxide (NaOH) mixture during 15 min

↓

The absorbance of extract solution was measured at 510 nm and was expressed as luteolin 7-*O*-glukozid (luteolin-7-G) equivalent /100 g fresh artichoke

2.11.Antioxidant Activity Analyses of Artichokes

Antioxidant activity analyses of artichokes were performed based on the 1,1-diphenyl-2-picryl-hydrazyl (DPPH) method described by Brand-Williams et.al.(1995) (n=2).

5 g of leave (or heart) part of artichoke was extracted with 80% (v/v) ethanol (EtOH) at ice-bath during 10 min

↓

900 μl of solutions in different concentration ranges (0.25–35 μg/ml) were treated with 900 μl 0.2 mM methanolic DPPH solution

↓

The absorbance of each mixture was spectrophotometrically (*Optima SP 300*) measured at 517 nm,immediately.

↓

After incubation at room temperature during 1,5,10,30 min, the absorbance of each mixture was again measured at 517 nm,immediately.

↓

DPPH radical-scavenging activity was expressed as inhibition percent and calculated based on the equation as shown below.

DPPH radical-scavenging activity (%) = (1 − antioxidant OD/ control OD) × 100

The method was validated [y= 12,33 x - 3,87 (R^2=0.9997)]

2.12.Heat Treatments of Artichokes

Three types of cooking methods (boiling, steaming, frying) were used. The optimized heat treatment conditions were applied for each artichoke. Testo 922 Dual Input Type K Thermocouple (Brandt Instruments, Inc., LA, USA) was used in temperature detection measurements for all heat treatments. In all cooking processes, same water with suitable pH (Erikli brand, pH 7.25) was used for the homogenize conditions and pH control of water was performed by Testo-206PH1 Tds (LA, USA) apparatus. All cooked samples with heat treatment were equilibrated to room temperature (25±1 ˚C) under the ice-bath (4±1 ˚C) conditions via rapid cooling for prevent the artichoke antioxidants. All heating processes were done as twice replication.

2.12.1. Boiling

Out bracte leaves of 6 of same calibre artichoke samples (*var*.Sakız 6 item; *var*.Bayrampaşa 6 item; as different experiment set) were peeled, washed and were transferred to stainless steel pan (Edition, *TEFAL*) including ½ pan boiled water and cooked at medium heat during 15 min. The excess water of boiled samples was decanted with colander about 40 sec, was equilibrated to room temperature (25±1 ˚C) and was prepared to analyses.

2.12.2. Steaming

Out bracte leaves of 6 of same calibre artichoke samples (*var*.Sakız 6 item; *var*.Bayrampaşa 6 item; as different experiment set) were peeled, washed and transferred to steam cooker (VC 1002 Ultra Compact Buharlı Pişirici,*TEFAL*) and were cooked with ¾ tea glass olive oil (*Tariş Naturel Sızma*).

Firstly, 1/3 proportion of water was transferred to water reservoir of steam cooker. Artichokes were placed to multilayered reservoirs of steam cooker, and olive oil was added, then cooked during 25 min and was equilibrated to room temperature (25±1 ˚C) after cooking and was prepared to analyses.

2.12.3. Frying

Out bracte leaves of 6 of same calibre artichoke samples (*var*.Sakız 6 item; *var*.Bayrampaşa 6 item; as different experiment set) were peeled, washed and were transferred to oiled oven tray (Oven:MF-26 GR Midi Oven, *VESTEL*) and were fried with ¾ tea glass olive oil (*Tariş Naturel Sızma*). 5 min frying was performed in adjustable oven to 170 ˚C. After the frying, the excess frying oil was removed with blotting paper about 15-20 sec and fried artichokes were equilibrated to room temperature (25±1 ˚C) and was prepared to analyses.

3.Results and Discussion

Figure 6 shows the standard and seperated sample HPLC chromatograms (Figure 6.). Average retention times (R.T.s) of cyanarin, caffeic acid and chlorogenic acid were 12.5 min, 15.7 min, 23.7 min, respectively in standard chromatogram whereas avg.retention times (R.T.s) of above mentioned compounds were 12.4 min, 15.6 min, 23.0 min, respectively in sample chromatogram (*var*.Bayrampaşa artichoke). It is shown that cyanarin, caffeic acid and chlorogenic acid were perfectly seperated by provided HPLC procedure (Figure 6.,chromatogram 1,2).

A mixture of cynarin (1,5-dicaffeoylquinic acid), chlorogenic acid (5-dicaffeoylquinic acid) and caffeic acid were perfectly simultaneously separated by an isocratic HPLC and a baseline resolutions was obtained as shown in Figure 6 first and second chromatogram (Figure 6.). Figure 6, second chromatogram shows that in artichoke sample [var.Bayrampaşa heart], cynarin (1,5-dicaffeoylquinic acid), chlorogenic acid (5-dicaffeoylquinic acid) and caffeic acid gave good base-line seperation and were determined, simultaneously (n=30) (Figure 6 second chromatogram). The quantification and

concentration determination of individual artichoke phenolic acids (cynarin, caffeic acid, chlorogenic acid) were obtained through calibration curves of standards by HPLC software. Our utilized extraction methodology and chromatographic seperation was shorter than that of studies and total elution time for three compounds was about 25 min. Not only was time saving but also economical determination regarding solvent consuming.

3.1. Phenolic Acids (Cynarin, Chlorogenic Acid, Caffeic Acid) Quantities

Cynarin, chlorogenic acid and caffeic acid quantities of heart, bracte leaves and head of artichoke samples as shown in Table 1.

In our study, major phenolic acid was found as cynarin (Cyn) in heart parts of artichokes and its level was found as 29483 ± 201 mg kg^{-1} in heart of artichoke *var*.Sakız and
was found as 18087 ± 21 mg kg^{-1} in heart of artichoke *var*.Bayrampaşa (p<0.01) (Table 1).

Cyn levels were 1512 ± 2 mg kg^{-1} ve 1058 ± 5 mg kg^{-1} in bracte leaves of *var*.Sakız and *var*.Bayrampaşa, respectively. It is shown that cynarin was the main compound of artichoke hearts and was found as 1.6 fold high in *var*.Sakız than var.Bayrampaşa (p<0.01) (Table 1.).

Figure 7 shows the phenolic acid amounts in heart and bracte leave parts of *var*.Sakız and *var*.Bayrampaşa in our study (Figure 7.).

Head part of artichokes includes heart and bracte leaves of artichokes. The present results demonstrated that both heart and bracte leaves and also sum total of heart and leaves, head part data were in our study and it has been put forwarded the importance of our study. In the literature, detailed study on phenolic compounds and polyphenols in all artihoche edible parts (head, heart and bracte leaves) are limited.

Romani et.al.(2006) were found polyphenol levels in different parts of typical Italian artichokes (*Cynara scolymus* L.) *var*.Violetto di Toscana and *var*.Terom. Chlorogenic acid (Clg) level had determined in bracte leaves of *var*.Violetto de Toscana and *var*.Terom, avg. 8.72 ± 6 mg kg^{-1} and avg. 2.53 ± 2 mg kg^{-1} by Romani et.al (2006). In our study, chlorogenic acid (Clg) levels were found as 3197± 27 mg kg^{-1} and 2379 ± 43 mg kg^{-1} in heart of artichokes *var*.Sakız and *var*.Bayrampaşa, respectively. Clg levels were found as 569± 3 mg kg^{-1} and 1263 ± 11 mg kg^{-1} in bracte leaves of artichokes *var*.Sakız and *var*.Bayrampaşa, respectively and it is seen that bracte leaves of artichokes in our study have very high Clg existence in comparison with Italian varieties (Table 1.) (Figure 7.). Romani et.al. (2006) showed that Clg amount had determined in head of *var*.Violetto de Toscana and *var*.Terom, avg. 30.51± 20 mg kg^{-1} and avg. 14.25 ± 10 mg kg^{-1} (Table 1.) while 3766 ± 30 mg kg^{-1} and 3642 ± 54 mg kg^{-1} were found in heads of our artichokes *var*.Sakız and *var*.Bayrampaşa,respectively and Clg level of our artichoke heads were very high (Table 1.) (Figure 7.).

Caffeic acid (Caf) concentration was found as 452±2 mg kg^{-1} ve 688±7 mg kg^{-1} in artichoke *var*.Sakız heart part and bracte leaves part, respectively whereas found as 106 ± 5 mg kg^{-1} ve 881 ± 3 mg kg^{-1} in artichoke *var*.Sakız heart part and bracte leaves part, respectively. It is determined that bracte leaves part included more caffeic acid than heart of artichokes in both varieties and it is seen that Caf levels of Sakız variety-heart was 4.2 fold higher than that of Bayrampaşa variety-heart (p<0.01) (Tablo 1.). Detailed data regarding caffeic acid which deproteinized form of chlorogenic acid in artichokes was not found in literature.

Romani et.al.(2006) stated that 63.57±48 mg kg^{-1}cynarin and 27.54±21 mg kg^{-1} cynarin in bracte leaves of artihocke *var*.Violetto di Toscana and *var*.Terom,respectively.In our artichokes 1512 ± 2 mg kg^{-1}cynarin and 1058 ± 5 mg kg^{-1}cynarin were detected in Sakız and

Bayrampaşa artichokes (Table 1.) (Figure 7.) and higher than literature data by Romani et.al.(2006).

It was reported the 253.35 ± 244 mg cynarin kg^{-1} in head of Violetto di Toscana artichoke and 95.02 cynarin ± 91 mg kg^{-1}in head of Terom artichoke by Romani et.al.(2006). In artichoke head *var*.Sakız and in artichoke head *var*.Bayrampaşa, cynarin concentration was extremely high and 30995 ± 203 mg kg^{-1} and 19145 ± 26 mg kg^{-1} of cynarin were determined, respectively (Table 1.) (Figure 8.). Figure 8 shows the phenolic acid levels in head of *var*.Sakız and *var*.Bayrampaşa in our study (Figure 8.). It has also been revealed that cyanidin was major compound in studied artichoke varieties. Especially heart part of studied artichokes were rich in cynarin and thereby cynarin profile has been determined extremely high in heads of Turkish artichokes, *var*.Sakız and *var*.Bayrampaşa. As overall, owing to the richness of their phenolic acid compositions, especially sources of cynarin compounds of Turkish artichokes, it has been stated their wealthiness of liver-hepatic functions and antioxidative availability.

3.2. Total Phenolic Acid, Total Flavonoid and Total Phenolics in Artichokes

In studied artichokes, total phenolic acid, total flavonoid and total phenolics were determined as shown in Table 2.

Total phenolic acids were determined as 33325.12 ±85 mg kg^{-1} in heart part of artichoke *var*.Sakız and while 20992.25 ±23 mg kg^{-1} in heart part of artichoke *var*.Bayrampaşa and 1.59 fold differency was found in each other (Table 2.). Total flavonoid levels was higher in artichoke *var*.Bayrampaşa (3302.78 ± 17 mg kg^{-1}) and was found 1.84 fold higher than artichoke *var*.Sakız (p<0.01) (Table 2.). Figure 9 shows total phenolic acids, total flavonoids and total phenolics in parts of studied artichokes (Figure 9.).

Total phenolic amounts was found as 35482,64 ±77 mg kg^{-1} in artichoke *var*.Sakız whereas 24438,14 ±38 mg phenolics kg^{-1} in *var*.Bayrampaşa and was 1.45 fold higher in Sakız artichokes (p<0.01). It is shown that both artichokes were good sources of phenolics (Table 2.).

Total phenolic acids (TPA) were found as 36097.31± 90 mg kg^{-1} in head of artichoke *var*.Sakız and while 24208.47 ± 26 mg kg^{-1} in heart part of artichoke *var*.Bayrampaşa. Sakız head was rich as 1.49 fold in phenolic acids (Table 2.). Romani et.al.(2006) stated that 287.92 mg kg^{-1} and 109.83 mg kg^{-1} of TPA in head of artichoke *var*.Violetto di Toscana and *var*.Terom,respectively. TPA in Turkish artihocke heads were higher about 84-125 fold than the study reported by Romani et.al.(2006). Romani et.al.(2006) found that 72.99 mg kg^{-1} and 30.46 mg kg^{-1} of TPA in bracte leaves of *var*.Violetto di Toscana and *var*.Terom,respectively. Based on our data, hovewer, total phenolic acids were lower than another parts in var.Sakız and var.Bayrampaşa, Turkish artichokes have very rich in phenolic acids. TPA in bracte leaves were 2772.19 ± 5 mg kg^{-1} and 3216.22 ± 3 mg kg^{-1} for *var*.Sakız and *var*.Bayrampaşa, respectively and at least 44 fold higher than the literature data. Detailed data concerning chlorogenic acid in artichokes was not found in literature.

Due to extremely Turkish artichoke-heart part have very high total phenolics, the total phenolic (TP) concentration of head parts have been extremely high (Table 2.) (p<0.01). Total phenolics were found as 40784.96 ± 83 mg kg^{-1} in head part of Sakız and 29952.6 ± 54 mg kg^{-1} in head part of Bayrampaşa (Table 2.). Romani et.al.(2006) reported 297.50 mg kg^{-1} and 111.81 mg kg^{-1} of total phenolics in Violette di Toscana and Terom artichokes, respectively. Romani et.al.(2006) also reported that total polyphenols level was 74.65 mg kg^{-1} and 32.09 mg kg^{-1} in bracte leaves of Violette di Toscana and Terom artichockes, respectively.In our study, total phenolics of bracte leaves were found as 5302.32 ± 6 mg kg^{-1} in Sakız artichokes and 5514.46 ± 16 mg kg^{-1} in Bayrampaşa

variety (p<0.01) (Table 2.), this bracte leaves data very high than Violette di Toscana and Terom. TP in heart parts of our artichokes were 35482.64 ±77 mg kg^{-1} for Sakız and 24438.14 ±38 mg kg^{-1} for Bayrampaşa artichokes. Detailed data study regarding TP in heart part of artichoke was not found in literature.

Total flavonoid (TF) content was also detected in bracte leaves of Sakız (2011.53 ± 4 mg kg^{-1}) and Bayrampaşa (1697.57 ± 8 mg kg^{-1}) and in our previous study, 3805.35 ± 6 mg kg^{-1} and 5000.35 ± 25 mg $kg^{-1}$of TF in head parts of Sakız and Bayrampaşa,respectively (p<0.01) (Table 2.). In the literature, avg.166 mg kg^{-1} of TF in bracte leaves while 198-958 mg kg^{-1} of TF in heads were reported in Italian artichokes (Romani et.al.,2006). As it is seen that our artichokes were rich in TF contents (Table 2). TF levels of heart part of Turkish artichokes were found as 1793.82 - 3302.78 mg kg^{-1} while detailed data study regarding TF in heart part of artichoke was not found in literature.

As overall evaluation, Turkish artihocke head>heads>bracte leaves were very rich in phenolic compounds (Table 1 and Table 2). Especially, alongside of normal consuming of heart and leaves (totally thereby head) as meal, heart parts can be used as canned food goods, bracte leaves powder can be used as food additive and nutraceutical food.

3.3. Major Anthocyanidins and Total Anthocyanin Quantities in Artichokes

Figure 10. shows the standards and seperated sample HPLC chromatogram of majör anthocyanidins in studied artichoke *var*.Sakız (Figure 10.). Average retention times (R.T.s) of cyanidin and peonidin were 2.58 min [$(R.T)_{peonidin}$= 2.58 min] for peonidin and 5.08 min for cyanidin [$(R.T)_{cyanidin}$= 5.08 min] in sample artichokes.

It is seen that cyanidin and peonidin anthocyanidins were perfectly simultaneously seperated by provided HPLCprocedure (Figure 10). As it is seen, cyanidin and peonidin were perfectly simultaneously determined with HPLC base-line seperation (n=30). The sugar moities containing glycosides were removed with the used method and were obtained aglycon forms as anthocyanidins. Total anthocyanidin content including glycosides was determined, spectrophotometrically (Table 3.).

In our study, majör anthocyanidin (aglycon form) was cyanidin in both artichoke varieties. In studied artichokes, cyanidin aglycon which gives orange-red colour, amount was found as 92.73 ± 3.1 μg^{-1}/100g (0.92 ± 0.03 mg kg^{-1}) in heart of artichoke *var*.Sakız while 101.11 ± 4.0 μg^{-1}/100g (1.01 ± 0.04 mg kg^{-1}) in heart of artichoke *var*.Bayrampaşa. It was detected that dominant aglycon form was cyanidin and its concentration was higher in heart part than that of in bracte leaves (p<0.01) (Table 3.) (Figure 11.).

Peonidin which give more colour, was found less in both varieties and was found higher concentration in bracte leaves of both artichokes (Table 3.) (Figure 11.). 156.84 ± 9.4 µg/100g (1.56± 0.09 mg kg^{-1}) and 154.42 ± 9.9 µg/100g (1.54± 0.09 mg kg^{-1}) of cyanidin aglycon in artichoke *var*.Sakız and *var*.Bayrampaşa,respectively and the levels of major aglycon cyanidin *var*.Sakız in accordance with *var*.Bayrampaşa. It is stated that individual aglycon levels in Turkish artichokes as shown in Table 3 and Figure 11 (p<0.01). Detailed study regarding individual aglycons in bracte leaves, in heart parts and in head parts of artichokes were not found in literature.

Total anthocyanin (TA) content of artichoke *var*.Sakız was determined as 912.28 ± 9.4 µg/ 100g (9.12 ± 0.09 mg kg^{-1}) and 2091.42 ±11.2 µg/100g (20.91± 0.11 mg kg^{-1}) in head parts of artichokes *var*.Sakız and *var*.Bayrampaşa, respectively. We reported that TA level was 2.3 fold higher in Bayrampaşa artichoke heart. TA amount was determined as 528.46± 1.2 µg/100g (5.28 ± 0.01 mg kg^{-1}) in bracte leaves of artichoke *var*.Sakız and there was no significant differences with

TA levels in *var*.Bayrampaşa (p<0.01). In artichokes, total anthocyanin levels in head part (including heart and bracte leaves) was also detected as shown in Table 3 and Fig.12.

In head parts of artichokes *var*.Sakız and *var*.Bayrampaşa, total anthocyanins were found as 1440.74±10.6 μg^{-1}/100g (14.40 ± 0.10 mg kg^{-1}) and 2589.78±13.5 μg^{-1}/100g (25.89 ±0.13 mg kg^{-1}), respectively and it is seen that artichokes were rich in anthocyanins. With regards to colour intensity, anthocyanidin compounds in Bayrampaşa artichokes was 1.8 fold higher than that of Sakız artichokes (p<0.01) (Table 3.) (Figure 12.).

Schütz et.al.(2006) had carried out anthocyanin characterization and quantification in artichokes varieties by high performance liquid chromatography-electrospray ionization mass spectrometry (HPLC-DAD-ESI-MS). Schüts et.al.(2006) reported that anthocyanin profilles (with glycoside compounds) in the heads of German artichokes (*Cynara scolymus* L.) *var*.“Camus”, *var*.“Green Globe”, *var*.“Le Castel”, *var*.“Petit Violet” and the heads of French artichokes (*Cynara scolymus* L.) *var*.“Buette” and *var*.“Poivrade”(Schütz et.al.,2006). Total anthocyanin level were determined as 8.4 – 1705.4 mg kg^{-1} in the study reported by Schütz et.al. (2006) and it has been stated that major anthocyanin compound was cyanidin-3-(6’’-malonyl) glycoside and delphinidin and two peonidin as the others.

In our present study, both individual anthocyanidins-cyanidin,peonidin as aglycons and also total anthocyanins were determined in bracte leaves, in hearts, in head part of artichokes and as it is seen that that is detailed research on artichoke parts. In the literature, total anthocyanins (TA) were found in head part of German artichoke *var*.“Petit Violet” as 8.4 ± 0.0 mg kg^{-1} and in head part of French artichoke *var*.“ Poivrade” as 20.8 ± 0.2 mg kg^{-1} (Schütz et.al., 2006). In our study, TA was determined as 14.40 ± 0.10 mg kg^{-1} (1440.74±10.6 µg/100g) in head of artichoke *var*.Sakız and as 25.89 ±0.13 mg kg^{-1} (2589.78±13.5µg/100g) in head of artichoke *var*.Bayrampaşa (Table 3) (Figure 11,12); especially TA level in var.Bayrampaşa was very high than German and French varieties. TA levels were found as 912.28 ± 9.4 µg/100g (9.12± 0.09 mg kg^{-1}) and 528.46± 1.2 µg/100g (5.28± 0.01 mg kg^{-1}) in heart and in bracte leaves of *var*.Sakız while 2091.42 ±11.2 µg/100g (20.91±0.11 mg kg^{-1}) and 498.36± 2.3 µg/100g (4.98± 0.02 mg kg^{-1}) in heart and in bracte leaves of *var*.Bayrampaşa, respectively. Detailed data study concerning total anthocyanins in bracte leaves and heart parts of artichokes were not found in literature. As it is seen, the importance of our study were revealed.

3.4. The Alterations in Artichokes by Heat Treatment Effects

In our study three different cooking methods were applied to samples (Part 2.12.) and monitored the alterations of phenolic profiles, selected parameters and antioxidant activities. The changes in phenolic profiles after boiling, steaming, frying were shown in Table 4 (p<0.01) (Table 4.).

3.4.1. The Alterations of Phenolic Acid Profiles After Boiling and Steaming

It is determined that after the heat treatment, especially caffeoylquinic acids levels importantly increased. Cynarin (1,3-di-*O*- caffeoylquinic acid) and chlorogenic acid (5-*O*- dicaffeoylquinic acid) of artichokes rised (p<0.01) (Table 4.) and it has been considered that the increasing of caffeoylquinic acids were owing the formed different dicaffeoylquinic acid isomers after heat treatments. High total phenolic acid levels of studied artichokes after heat treatments have been verified our remarks on forming of different dicaffeoylquinic acid isomers (p<0.01) (Table 4.). Especially via the boiling effect, phenolic acid levels of artichokes mostly increased by comparison to steaming and frying, respectively (p<0.01) (Table 4.) (Table 4.1.). Between

the dicaffeoylquinic acid concentrations formed after steaming and frying were not found significant difference as statistically (p<0.01) (Table 4.) (Table 4.1.).

Chlorogenic acid (Clg) level in bracte leaves of *var*.Sakız was 1354.22± 19 mg kg^{-1} after boiling process and was found as 2.38 fold high in comparison to raw form while its level was 6745.67 ±152 mg kg^{-1}in heart part of Sakız and was detected as 2.11 fold increased in comparison with raw heart form. In boiled head part of artichoke *var*.Sakız, 8099.89 ±171 mg kg^{-1} of chlorogenic acid (5-*O*-caffeoylquinic acid) was detected and was 2.15 fold higher than its raw head form (p<0.01) (Table 4). After boiling process, in bracte leaves of Bayrampaşa, 2867.01 ± 8 mg kg^{-1} of Clg was found and its level was 2.27 fold higher than its concentration in raw leaves whereas 6994.26 ±93 mg kg^{-1} of Clg was determined in heart part of Bayrampaşa and it was 2.94 fold high from raw heart of Bayrampaşa (p<0.01) (Table 4).

It was found that boiled head part of Bayrampaşa included 9861.27 ±93 mg kg^{-1} of Clg and this boiled form contained 2.7 fold high in Clg (p<0.01) (Table 4).

After boiling, cynarin (1,3-di-*O*-caffeoylquinic acid) content was found as 8.02 and 8.42 fold high in boiled bracte leaves and boiled heart forms, respectively. With the boiling process, the raising of major artichoke phenolic substance cynarin was considerably high in comparing to that of chlorogenic acid (p<0.01) (Table 4). It is stated that due to the dicaffeoylquinic acid groups of cynarin, it has been formed more isomers, likewise chlorogenic acid (5-*O*-caffeoylquinic acid) is monocaffeoylacid group. Figure 13 shows the cynarin (1,3-di-*O*- caffeoylquinic acid) level after boiling and steaming process (Figure 13).

After boiling process, total phenolic acids (TPA) in heart parts of Sakız and Bayrampaşa were found as 63531.26 ± 163 ve 58638.56 ± 87 mg kg^{-1} and it was found that 1.76 and 2.4 fold increasings in their concentrations,respectively after the boiling (p<0.01) (Table 4.).

With steaming process, TPA in head of *var*.Sakız and *var*.Bayrampaşa was found as 75602.19 ±66 and 70952.66 ± 61 mg kg^{-1} and was detected 2.09 and 2.93 fold raising in their TPA amounts after steaming. In steaming forms, phenolic acid contents of *var*.Sakız and *var*.Bayrampaşa were 1.19 and 1.21 fold high,comparison to their boiled forms, respectively.
(p<0.01) (Table 4.).

After the cooking at steam, cynarin (1,3-di-*O*-caffeoylquinic) level was 81219.44 ±89 mg kg^{-1} in head of Bayrampaşa artichoke variety and was detected as 4.24 fold raising in cynarin concentration of steamed heads, as comparing to raw heads (p<0.01) (Table 4.).

In steamed forms, cynarin contents were lower in Sakız and Bayrampaşa, comparing to boiled forms and were detected 2.34 and 2.14 fold lower (p<0.01) (Table 4.). From the point of total phenolic acid (TPA) content, in artichokes, hovewer TPA of steamed forms were high, individual cynarin contents were higher in boiled forms (p<0.01) (Table 4.). The establishing of these findings were notable for our study. Due to it is known more strong antioxidant and liver protector (hepatoprotective), anti-LDL effects of cynarin which is the major phenolic compound of artichoke; regarding findings on mostly high concentration of cynarin in boiled artichokes and regarding findings on good levels of cynarin in steam cooking were notable for consumers (Table 4.).

After steaming process, chlorogenic acid was found in steamed head parts of *var*.Sakız and *var.* Bayrampaşa as 6439.86 ±43 and 6154.98 ±24 mg kg^{-1} and 1.71 and 1.69 fold rising was found, respectively (Table 4.). As it is known, chlorogenic acid (Clg) is strong antioxidant, liver-gallbladder-friendly, anti-cancer and antimicrobial agent. It is shown that with boiled artichoke or steam cooked artichoke, high concentrations of Clg can be absorbed. Our study has been put forwarded the notable data. In steamed forms, cynarin contents were detected as 1.26 and 1.6 fold

lower than their boiled forms in *var*.Sakız and in *var*.Bayrampaşa, respectively, but both boiled and steamed forms can be fruitfull (p<0.01) (Table 4.).

3.4.2. The Alterations of Total Flavonoids, Total Phenolics After Boiling and Steaming

In the head parts of *var*.Sakız, after the boiling, total flavonoid levels were found as 2782.94 ± 23 mg kg^{-1} luteolin-7-*O*-glukozid equivalent (p<0.01) (Table 4.). It was stated that total flavonoids level affected by boiling process and was detected 1.36 fold decreasing (Table 4.).

Total flavonoid (TF) levels of steamed *var*.Sakız was found as 2954.45 ± 34 mg kg^{-1} luteolin-7-*O*-glukozid equivalent and was 1.28 fold lower than that of raw forms. TF levels in boiled head of *var*.Bayrampaşa and in steamed head of same cultivar were 4717.31 ± 10 mg kg^{-1} and 4733.83 ± 23 mg kg^{-1} luteolin-7-*O*-glukozid equivalent and there was no significant difference regarding the cooking losses between two processing, statistically (p<0.01) (Table 4.). As TF quantity, the cooking losses in both method were not high, thereof, the consuming of boiled or steamed artichokes can be healthy for consumers owing to they are also good flavonoid sources with antioxidative, auxiliary of anticancer, LDL cholesterol inhibition properties (Table 4.).

Total phenolic (TP) substances in boiled head of *var*.Sakız was 252866.75±127 mg Clg/kg and TP in steamed head of *var*.Sakız 228388.55± 138 mg Clg/kg. In Bayrampaşa variety, TP level was 188400.43 ±92 and 186969.12 ±110 mg Clg/kg, after boiling and steaming processes, respectively. In both varieties, with boiling and steaming, about 6.2 and 5.6 fold increasing were determined, compared to their raw forms (p<0.01) (Table 4.). Figure 14 shows the alterations in total phenolic acids, total flavonoids and total phenolics of studied artichokes after boiling and steaming (Figure 14).

In our study, it has been put forwarded that boiling or steaming were effective cooking methods for maximum phenolic availability from artichoke vegetable (p<0.01) (Tablo 4.).

3.4.3. The Alterations of Anthocyanidins (Aglycons), Total Anthocyanins After Boiling and Steaming

After boiling, in head of *var*.Sakız, total anthocyanin (Tantho) quantities were found 2780.62 ±105 µg /100g as cyanidin-3-glycoside (C3G) equivalent and was detected as 1.93 fold high total anthocyanin in comparing to raw form whereas Tantho quantities were 1383.11 ±58 µg C3G /100g in head of *var*.Sakız with steam cooking application and was detected 1.04 fold decreasing than that of raw form (p<0.01) (Tablo 4.). It is considered that the duration of boiling application was 15 min and the duration of steaming cooking was 25 min (parts 2.12.1. and 2.12.2.), due to the longer heating process duration in steaming, it may be ring opening in unstable anthocyanin compounds, so a far amount of anthocyanin loss may be in steam cooking of artichokes, comparing to raw form. It is stated that the proposed mechanism the convertion of cyanidin aglycon to cyanidin 3-glycosid and cyanidin 3,5-di-glycoside (Figure 15.) (Anonymous,2005).

Aglycon form (anthocyanidin) has been formed via attaching of sugar moities from 3. and 5. sites of the molecule, cyanidin-glycoside forms has been increased with the boiling process. It has been commented that sugar (glycoside) content of vegetable may complex to colour compounds, merely, within the longer heating time, it may be the openings from O^+ position of the ring or it may be rupture from sites attached of glycosides in the ring or it may be the conversions in the molecule (Anonymous,2005;Tokuşoğlu & Başay , 2009).

With the boiling effect, in the head of Bayrampaşa, total anthocyanin (TA) quantity was found as 5904.69 ±77 µg /100g (as cyanidin-3-glycoside,C3G,

equivalent) and was detected as 2.28 fold increasing in TA content. After the steam cooking, TA levels was determined as 2686.78 ±25 µg C3G /100g in head of *var*.Bayrampaşa, comparing to raw form. As it was seen that TA levels had not decreased in steamed *var*.Bayrampaşa,compared to steamed *var*.Sakız; this result may be interpreted that the sugar content of *var*.Bayrampaşa was higher than that of *var*.Sakız (p<0.01) (Table 4.).

Artichoke colour substances, anthocyanins are strong antioxidants, effective on specific cancer types and have positive effects on health of urinary system (urinary tract system and urologic system), important constituents on memory functions and eye health (Anonymous,2008; Tokuşoğlu & Başay,2009).

Cyanidin aglycon level was identified in boiled head of *var*.Sakız and in boiled head of *var*.Bayrampaşa as 68.19±4 µg/100g and 65.97±5 µg/100g, respectively was found as about 50% of decreasing in both varieties, comparing to raw forms (p<0.01) (Table 4.).

For effective availability of artichoke anthocyanins, boiling >steaming cooking were effective consuming methods, respectively (p<0.01) (Table 4.). After steam cooking, 35.78 ±12 µg/100g of cyanidin aglycon was detected in head of Bayrampaşa and was determined the 4.3 fold of decreasing in raw head form (p<0.01) (Table 4.). The more cyanidin decreasing in *var*.Bayrampaşa may be due to the more dark green content of *var*.Bayrampaşa. It may be interpreted that the dark green colour content of artichoke may be more increase and also its in cyanidin content may be more decrease. For our hypothesis verification, *L*a*b** Colour-Hunter values were measured and it is determined the a values (redness) decreasing. In heart part of the artichokes, it was detected the same level of cyanin stability (p<0.01) (Table 4.).

3.4.4. The Alterations of Major Phenolic Profiles After Frying

After frying (part 2.12.3.) process, cynarin was found in head of *var*.Sakız and in head of *var*.Bayrampaşa as 74078.21 ±155 ve 43650.52 ±103µg/100g and it was detected as 2.39 and 2.28 fold increasing of cynarin for *var*.Sakız and *var*.Bayrampaşa, respectively, in comparing to raw forms (p<0.01) (Table 5.). With frying, chlorogenic acid quantity rised as 2.13 fold in *var*.Sakız and as 1.9 fold in *var*.Bayrampaşa (p<0.01) (Table 5.).

Total phenolic acids was determined as 65697.23±42 µg/100g in fried head of *var*.Sakız and was detected 1.82 fold increasing, in comparison to raw head (p<0.01) (Table 5.). After frying, total flavonoid content was 1953.26 ± 23 and 1452.42 ±50 µg/100g luteolin-7-*O*-glikozid in Bayrampaşa head and in Sakız head,respectively and was detected 2.56 and 2.62 fold of decreasing (p<0.01) (Table 5.).

After frying process, total phenolics (TP) was determined in fried head of *var*.Sakız and was detected as 3.34 fold high (136218.56 ±97 µg/100g Clg equivalent). In fried head of *var*.Bayrampaşa, TP levels was found as 104235.05 ±111 µg/100g and was determined 3.48 fold increasing. After the frying, 3.14 and 3.05 fold decreasings were obtained in total anthocyanin (TA) content (p<0.01) (Tablo 5.). Owing to the intensity of glycosid groups of *var*.Bayrampaşa, 849.108 ±4 µg/100g cyanidin-3-*O*-glycosid equivalent was detected in head of Bayrampaşa artichokes and 1.85 fold higher than that of fried var.Sakız head (p<0.01) (Tablo 5.).

Figure 16 shows total anthocyanin levels of artichoke heads after frying process (Figure 16.) Cyanidin aglycon was determined in *var*.Sakız and *var*.Bayrampaşa as 29.89 ±5 and 30.06 ±2 µg/100g respectively and was found 5.25 and 5.14 fold of decreasings, comparing to their raw forms (p<0.01) (Tablo 5.).

After frying process, phenolics were also good levels in fried artichokes and were detected increasing levels in some phenolic profiles (p<0.01) (Tablo 5.). Artichoke frying is alternative consuming to boiling and steam cooking of artichokes, also aroma and flavor

compounds has been formed in frying. In this point, frying time and frying temperature must be controlled and also frying oil quality must be considered for frying process.

Ferracane et.al. (2008) were determined that changing of phenolic caffeoylquinic acid isomers, apigenin derivatives of cooked Italian artichokes with various cooking procedures (Ferracane et.al.,2008). Ferracane et.al. (2008) reported that about 60% of increasings in total caffeoylquinic acids
in steamed Italian artichokes. It was no significant alteration in apigenin phenolics in Italian artichokes (Ferracane et.al.,2008).

3.5. Antioxidant Activity in Artichokes

Antioxidant activity (AA) is a measurement of free radical distinctness ability of products. In our study, with DPPH method, antioxidant activities of raw, boiled, steamed, fried artichokes *var*.Sakız and *var*.Bayrampaşa were determined as Trolox equivalent (p<0.01) (Tablo 6.). Especially in boiled and steamed artichokes, it was determined the highest AA levels (p<0.01) (Table 6.).

In Turkish artichokes, the increasing of AA was about7 fold in boiled form, was about 11 fold in steamed form and also was about 5.5 fold in fried forms of artichokes (p<0.01) (Table 6.) (Figure 17.). Ferracane et.al.(2008) reported that the increasing of AA was 8 fold in boiled Italian artichokes whereas that of was about 15 fold in steam cooked Italian artichokes. Several research were found on antioxidant activity of artichokes (Fratianni et.al.,2007; Lattanzio et.al.,2005; Alamanni et.al.,2003) in literature but one research was found for comparable to our data. Our study data on AA was in accordance with that study by Ferracane et.al.(2008) however processing procedure differency was.

cooked Italian artichokes. Several research were found on antioxidant activity of artichokes (Fratianni et.al.,2007; Lattanzio et.al.,2005; Alamanni et.al.,2003) in literature but one research was found for comparable to our data. Our study data on AA was in accordance with that study by Ferracane et.al.(2008) however processing procedure differency was.

4. Conclusion

In our performed study, various phenolic parameters were examined in two raw artichoke varieties and were also identified phenolic profiles after cooking processes including boiling, steaming and frying. It is seen thet our study was detailed on individual phenolic acids;caffeoylquinic acids, total flavonoids,total phenolics, anthocyanidins, total anthocyanins, antioxidant activity and their alterations on cooking processing effects. This previous study on phenolic profiles of processed artichokes has been given the strong data for food science and technology literature.

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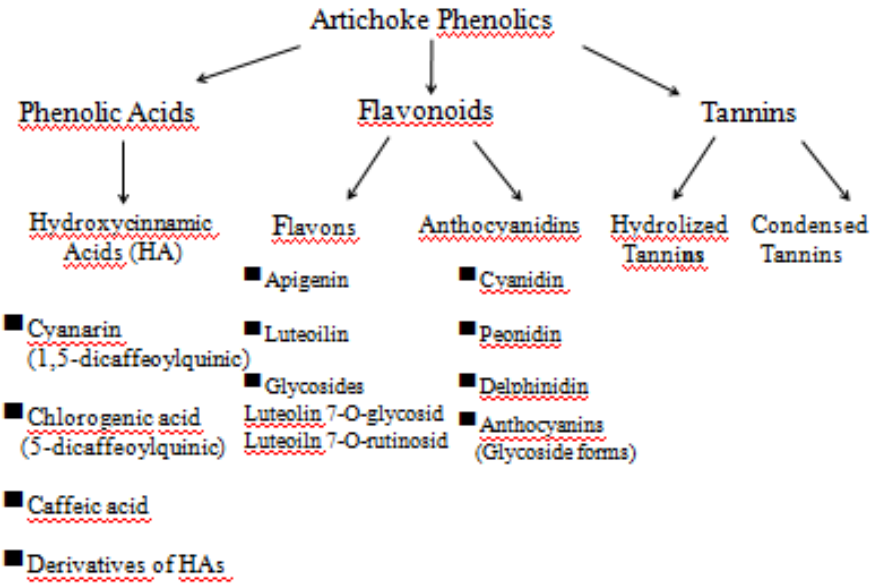
FIGURES



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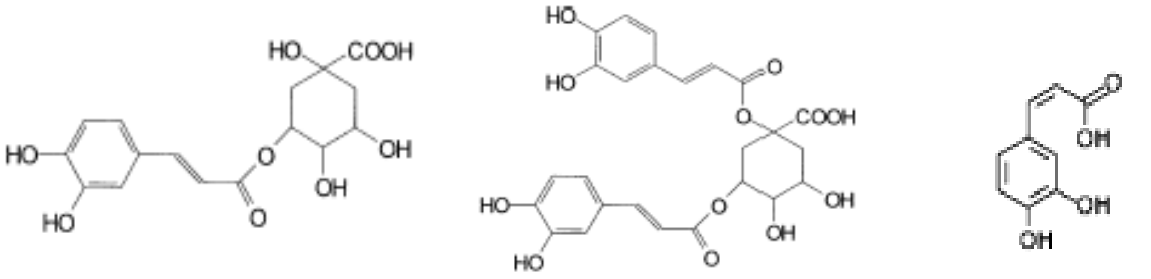
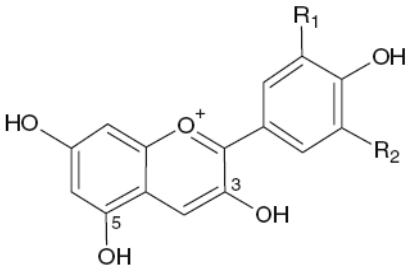


Chlorogenic Acid (5-Dicaffeoylquinic Acid)

Cynarin (1,5-Dicaffeoylquinic Acid)

Caffeic Acid

Figure 2.

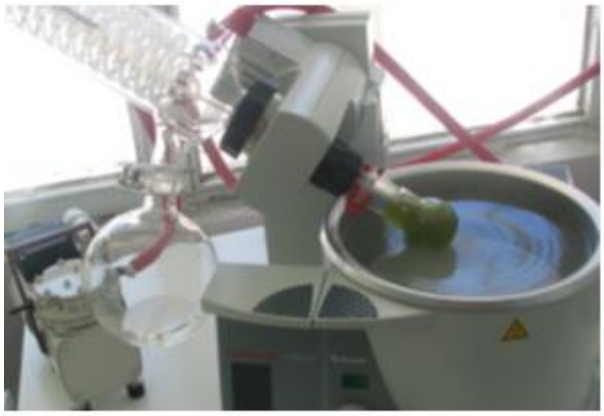


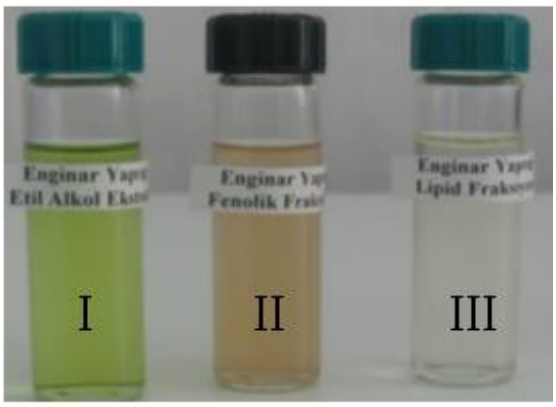
Compound	R_1	R_2
Siyanidin	OH	H
Peonidin	OCH_3	H

Figure 3.

Figure 4a.

Figure 4b.





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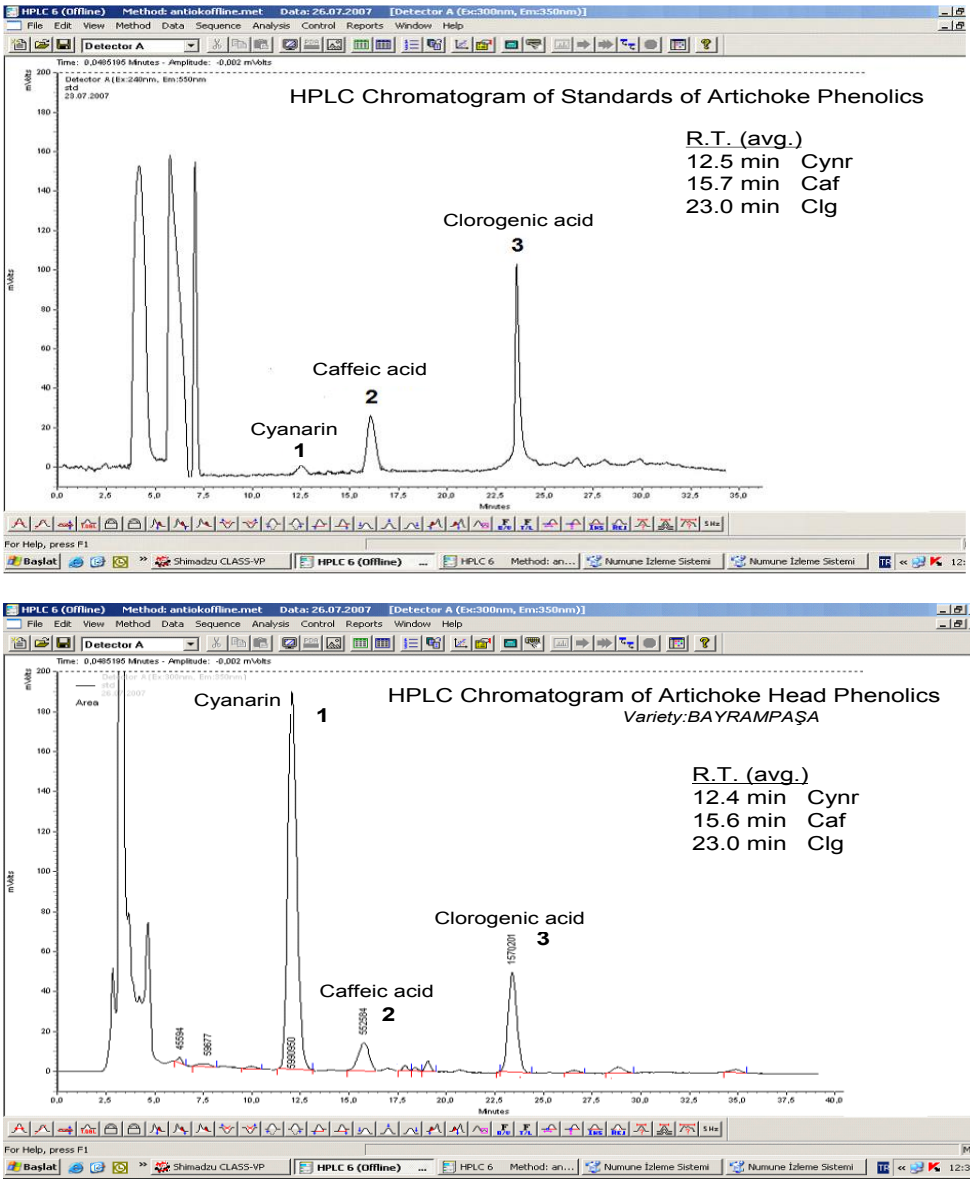

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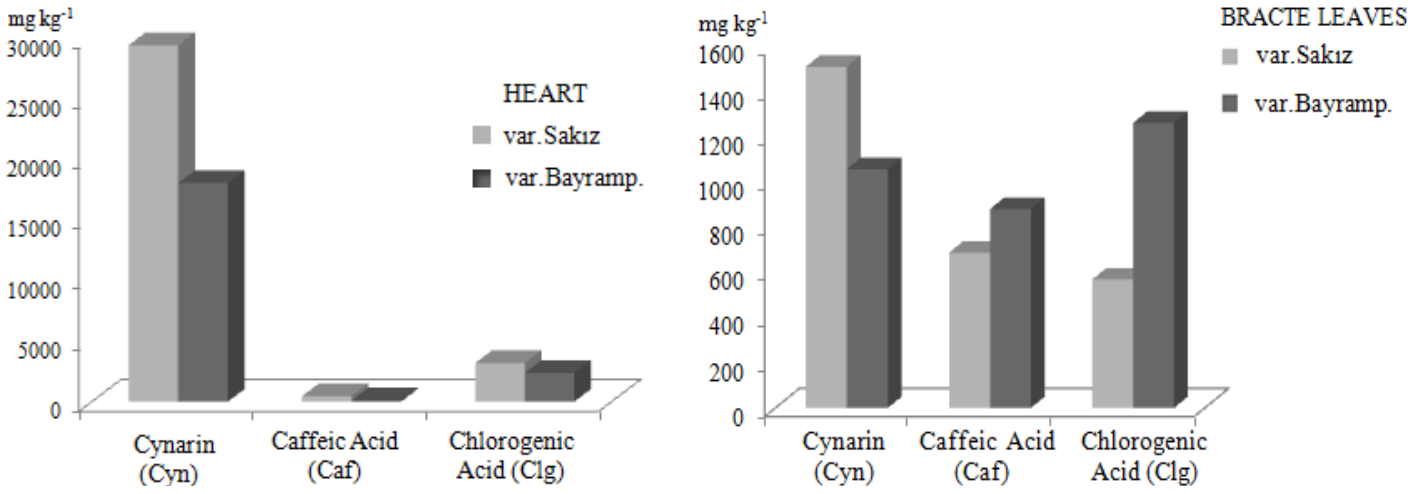

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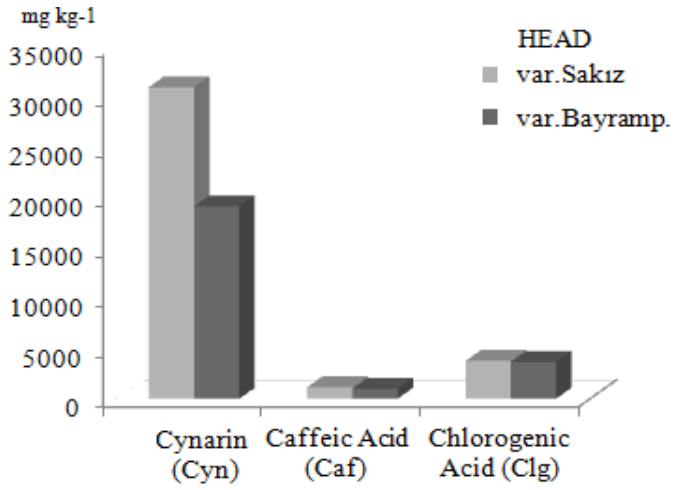

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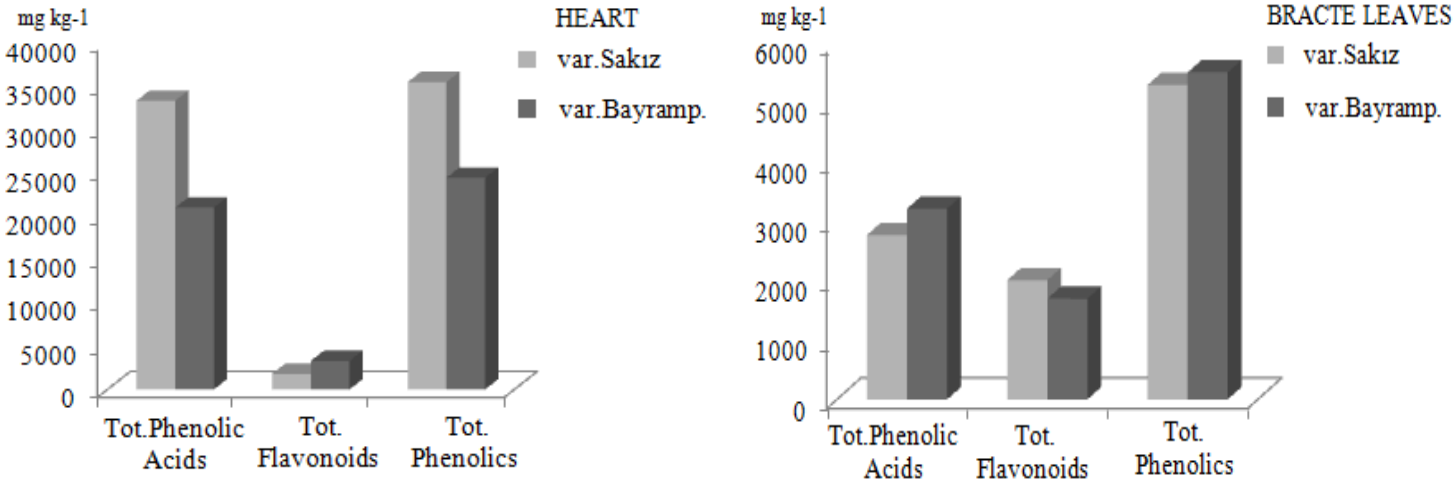

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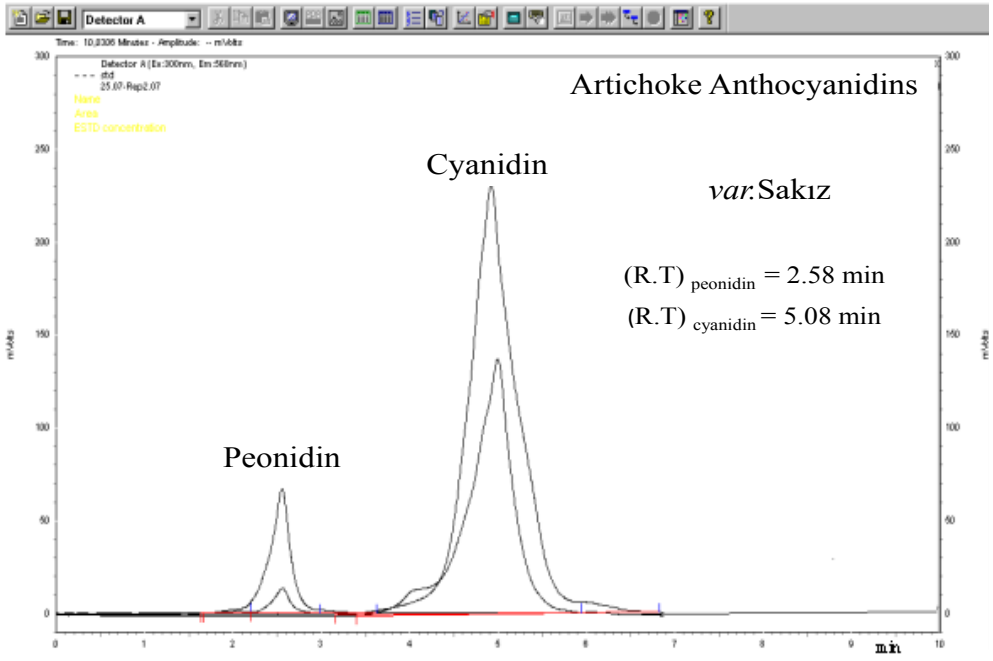

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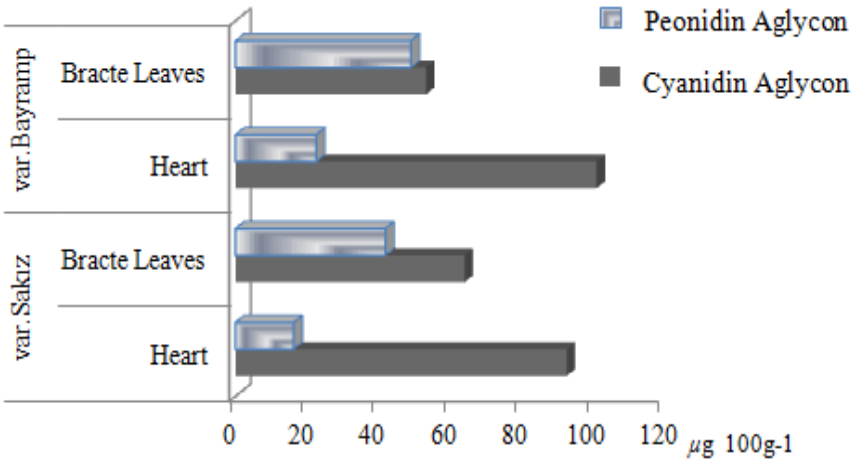

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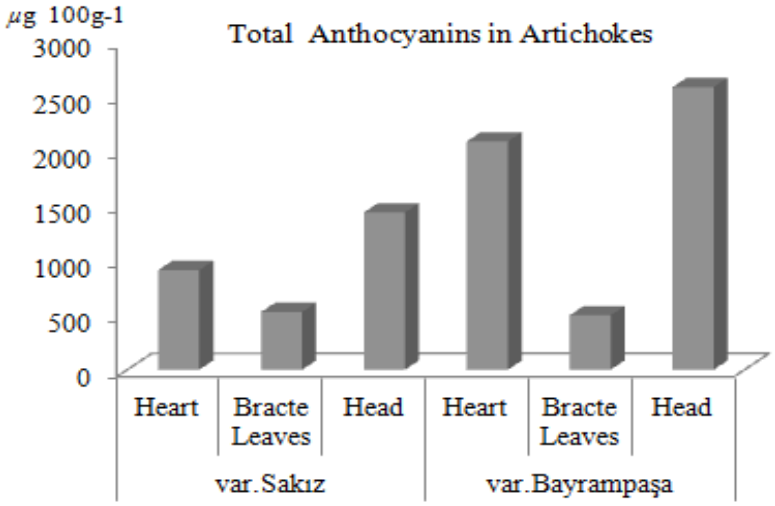

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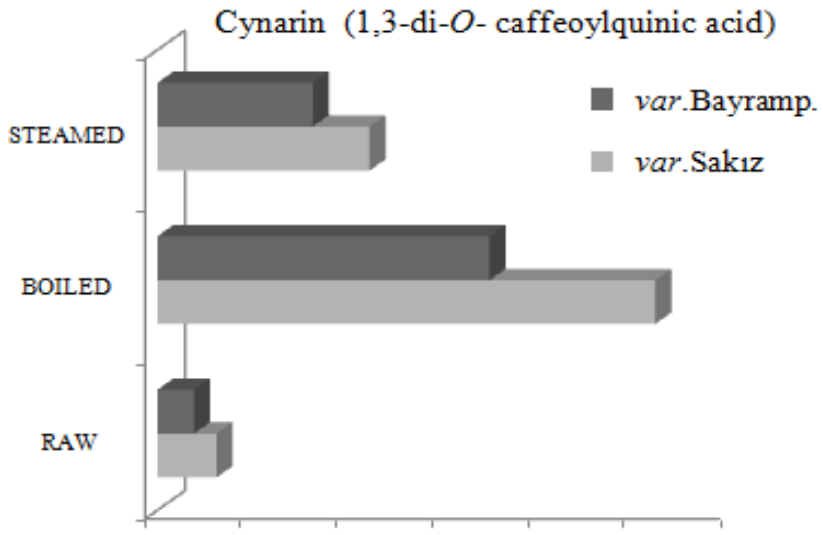

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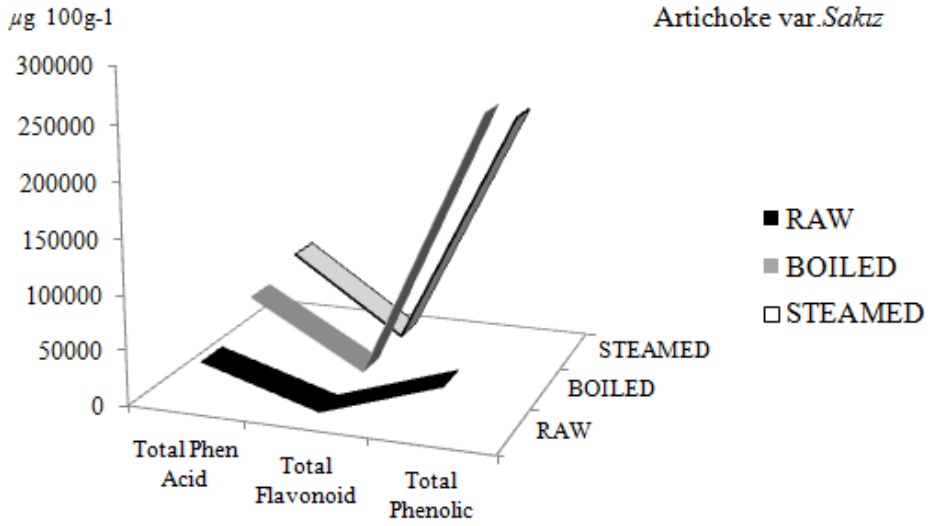

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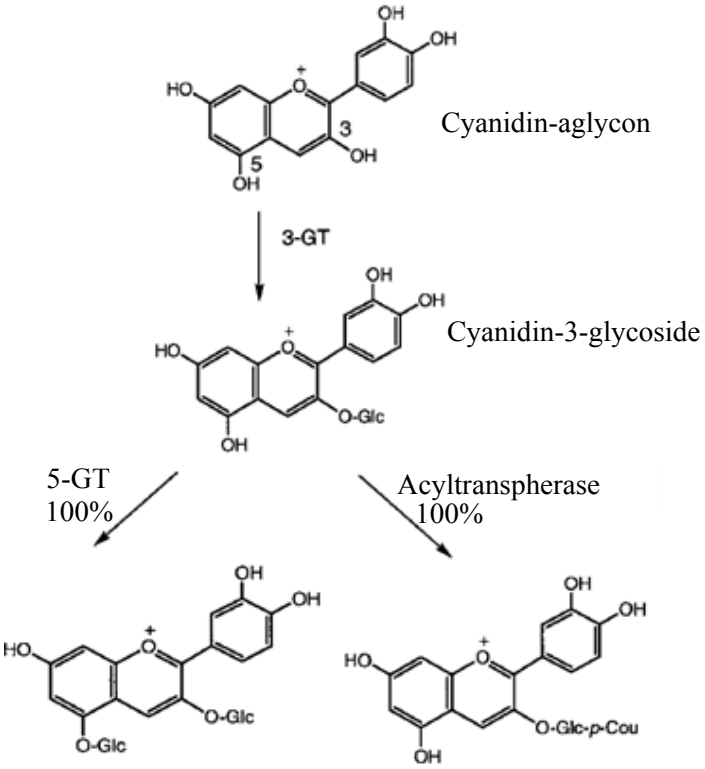

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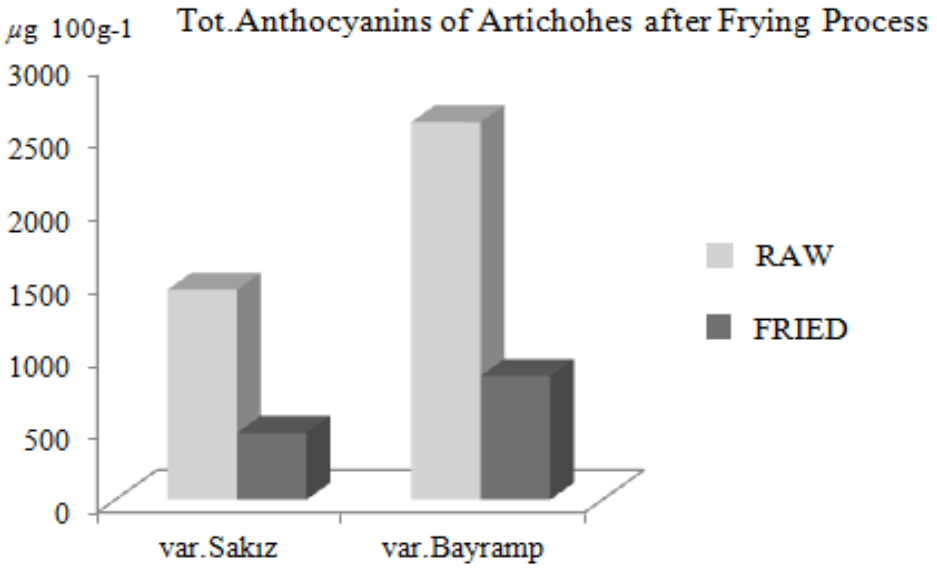

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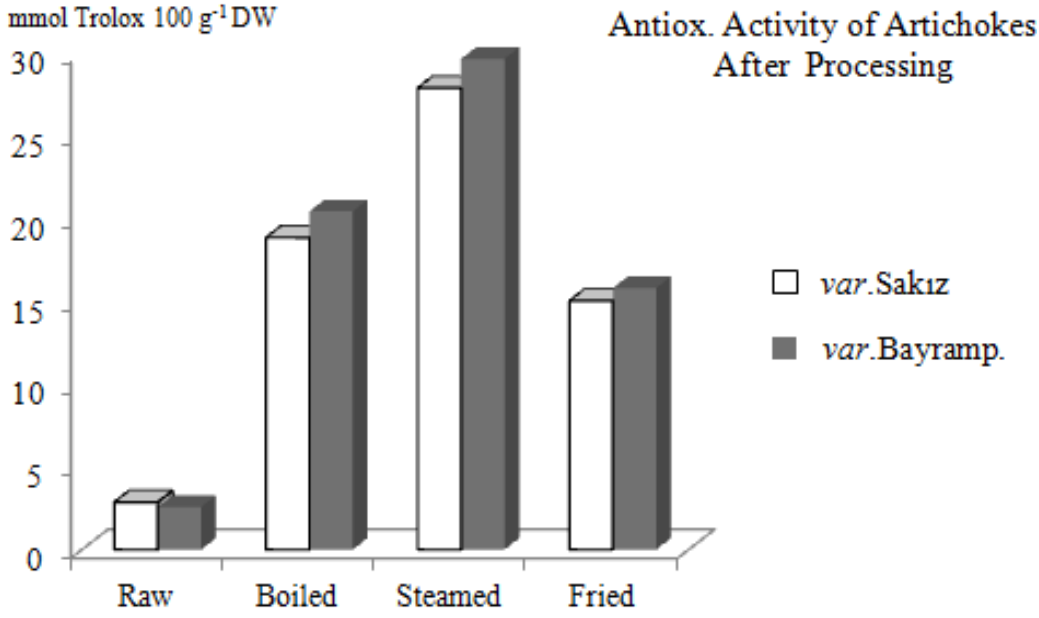

Figure 17.

Table 1. Phenolic Acid Levels of Artichokes*

	Artihocke Varieties					
Parameters	*var*.Sakız			*var*.Bayrampaşa		
(mg kg^{-1})	Heart	Leave	Head	Heart	Leave	Head
Cynarin (Cyn)	29483 ±201	1512 ± 2	30995 ± 203	18087 ± 21	1058 ± 5	19145 ± 26
Caffeic Acid (Caf)	452 ± 2	688 ± 7	1140±9	106 ± 5	881 ± 3	987±8
Chlorogenic Acid (Clg)	3197 ± 27	569 ± 3	3766 ± 30	2379 ± 43	1263 ± 11	3642 ± 54

□*(p*<0.01); *n*=30; as mg kg^{-1} FW

Table 2. The Levels of Total Phenolic Acid, Total Flavonoid and Total Phenolics In Artichokes

	Artichoke Varieties					
Parameters	*var*.Sakız			*var*.Bayrampaşa		
(mg kg^{-1})	Heart	Bracte Leaves	Head	Heart	Bracte Leaves	Head
Total Phenolic Acids	33325.12 ±85	2772.19 ± 5	36097.31± 90	20992.25 ±23	3216.22 ± 3	24208.47 ± 26
Total Flavonoids	1793.82 ± 2	2011.53 ± 4	3805.35 ± 6	3302.78 ± 17	1697.57 ± 8	5000.35 ± 25
Total Phenolics	35482.64 ±77	5302.32 ± 6	40784.96 ± 83	24438.14 ±38	5514.46 ± 16	29952.6 ± 54

□*(p*<0.01); *n*=30; as mg kg^{-1} FW

Table 3. The Levels of Individual Anthocyanidins and Total Anthocyanins in Artichokes*

	Artihoche Varieties					
Parameters	*var*.Sakız			*var*.Bayrampaşa		
(μg 100 g^{-1})	Heart	Bracte Leaves	Head	Heart	Bracte Leaves	Head
Cyanidin Aglycon	92.73 ± 3.1	64.11± 6.3	156.84 ± 9.4	101.11 ± 4.0	53.31± 5.9	154.42 ± 9.9
Peonidin Aglycon	16.22± 2.7	41.95± 9.0	58.17± 11.7	22.55 ± 2.2	49.07± 3.6	71.62 ± 5.8
Total Anthocyanins	912.28 ± 9.4	528.46± 1.2	1440.74±10.6	2091.42 ±11.2	498.36± 2.3	2589.78±13.5

□*(p*<0.01); *n*=30; as μg 100 g^{-1} FW; In the text, the data was also compared as mg kg^{-1} (convertion; μg g^{-1} = mg kg^{-1})

Table 4. The Alterations in Major Phenolic Profiles of Boiled and Steamed Processed Artichockes(as μg $100g^{-1}$)

					Heat Treatments					
Compound	**Variety**	**Raw**			**Boiled**			**Steamed**		
		Bracte Leave	**Heart**	**Head**	**Bracte Leave**	**Heart**	**Head**	**Bracte Leave**	**Heart**	**Head**
Cynarin	Sakız	1512 ± 2	29483 ± 201	30995 ± 203	12126.23± 78	248246.86 ±185	260373.09 ±263	4868.64 ±21	106093.46 ±125	110962.1 ±146
	Bayrampaşa	1058 ±5	18087 ±21	19145 ± 26	9978.55± 113	163678.41 ±92	173656.96 ±205	3159.18 ±9	78060.26 ±80	81219.44 ±89
Chlorogenic Acid	Sakız	569 ± 3	3197 ± 27	3766 ± 30	1354.22 ± 19	6745.67 ±152	8099.89 ±171	938.85 ±12	5501.01 ±31	6439.86 ±43
	Bayrampaşa	1263 ± 11	2379 ± 43	3642 ± 54	2867.01 ± 8	6994.26 ±93	9861.27 ±93	2089.29 ±7	4065.69 ±17	6154.98 ±24
Total Phenolic Acid	Sakız	2772.19 ± 5	33325.12 ±85	36097.31± 90	4684.68 ± 11	58846.58 ±56	63531.26 ± 67	5246.84 ±27	70355.35±39	75602.19 ±66
	Bayrampaşa	3216.22 ± 3	20992.25 ±23	24208.47 ± 26	5628.22 ± 17	53010.34 ±70	58638.56 ± 87	6093.64± 15	64859.02 ± 46	70952.66 ± 61
Total Flavonoid	Sakız	2011.53 ± 4	1793.82 ± 2	3805.35 ± 6	1399.18 ± 5	1383.76 ± 18	2782.94 ± 23	1418.2 ± 8	1536.25 ± 26	2954.45 ± 34
	Bayrampaşa	1697.57 ± 8	3302.78 ± 17	5000.35 ± 25	1515.66 ± 3	3201.65 ±7	4717.31 ± 10	1610.63± 14	3123.2 ±9	4733.83 ± 23
Total Phenolic	Sakız	5302.32 ± 6	35482.64 ±77	40784.96 ± 83	32988.54 ±85	219878.21±42	252866.75±127	29145.79±51	199242.11±87	228388.55± 138
	Bayrampaşa	5514.46 ± 16	24438.14 ±38	29952.6 ± 54	35123.31 ±23	153277.12 ±69	188400.43 ±92	30309.56 ±34	156659.56±76	186969.12 ±110
Tot.Anthocyanin	Sakız	528.46± 1.2	912.28 ± 9.4	1440.74±10.6	1167.89 ± 19	1612.73 ±86	2780.62 ±105	493.27 ±40	889.84 ±18	1383.11 ±58
	Bayrampaşa	498.36± 2.3	2091.42±11.2	2589.78±13.5	1041.57 ±33	4863.12±44	5904.69 ±77	510.38±19	2176.4 ±6	2686.78 ±25
Cyanidin Aglycon	Sakız	64.11± 6.3	92.73 ± 3.1	156.84 ± 9.4	22.10 ±2	46.09 ±2	68.19±4	18.94 ±4	23.67 ±3	42.61 ±7
	Bayrampaşa	53.31± 5.9	101.11 ± 4.0	154.42 ± 9.9	19.78 ±1	46.19 ±4	65.97±5	16.88 ±1	18.9 ±11	35.78 ±12

Table 5 . The Alterations in Phenolic Profiles in Artichokes After Frying (as μg 100g^{-1})

		Raw	**Frying**
		Head	Head
Cynarin (1,3-dicaffeoylquinic acid)	*Sakız*	30995 ± 203	74078.21 ±155
	Bayrampaşa	19145 ± 26	43650.52 ±103
Chlorogenic Acid (5-*O*-caffeoylquinic)	*Sakız*	3766 ± 30	8021.58 ±73
	Bayrampaşa	3642 ± 54	7243.20 ±54
Total Phenolic Acid	*Sakız*	36097.31± 90	65697.23 ±42
	Bayrampaşa	24208.47 ± 26	42848.77 ±66
Top.Flavonoids *(as Lutein-7-G)*	*Sakız*	3805.35 ± 6	1452.42 ± 50
	Bayrampaşa	5000.35 ± 25	1953.26 ± 23
Total Phenolic (*as Clg*)	*Sakız*	40784.96 ± 83	136218.56 ±97
	Bayrampaşa	29952.6 ± 54	104235.05 ±111
Total Anthocyanin (*as C3G*)	*Sakız*	1440.74±10,6	458.834 ±15
	Bayrampaşa	2589.78±13,5	849.108 ±4
Cyanidin Aglycon	*Sakız*	156.84 ± 9,4	29.89 ±5
	Bayrampaşa	154.42 ± 9,9	30.06 ±2

Table 6. Antioxidant Activity Levels of Sakız and Bayrampaşa Artichoke Heads

Antioxidant Activity (mmol Trolox 100 g^{-1} DW)				
Variety	Raw	Boiled	Steamed	Fried
Sakız	2.87± 0.03	18.87± 0.22	27.92 ± 0.83	15.04 ± 0.58
Bayrampaşa	2.58± 0.02	20.46± 0.64	29.68 ± 0.80	15.82 ± 0.58

p<0.01; n=30

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Studying the Consumer Preferences and Consumption Attitudes of Traditional Tarhana

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Abstract

This research was carried out to determine the attitudes towards the consumption of tarhana which is an important traditional taste and also accepted as a functional food. In the study, composition, nutritional value and widespread use of tarhana were directed to 302 individuals with different sociodemographic characteristics, and it was aimed to reveal the factors affecting their consumption attitudes by evaluating the obtained answers.

As a result of the research, it was determined that the majority of the participants had information about the production and consumption of tarhana. While consumers living in rural areas are aware of the consumption of tarhana in different ways other than soup, this ratio is decreasing in some regions. While it was determined that sensory properties such as taste and smell in the use of tarhana, consumption style also changed consumer attitude, it was observed that the participants had a certain level of knowledge about the production and storage conditions. Another result obtained from the study is that to prevent loss of healthy local products like tarhana and increase prevalance in the national or international markets, effective marketing and advertising activities is needed.

Keywords: Tarhana, Consumer Preferences, Local Foods, Consumer Attitudes

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Instraction

Tarhana is one of the most important traditional fermented semi-ready foods in Turkey. According to literature, Turkish people in Middle Asia were the first to produce it. Afterwards, it spread to different parts of the world (Gurbuz et al. 2011). There are 17 different types of tarhana found in different regions of Turkey. These are Ege, Trakya, Gediz, Sivas, Maraş, Beyşehir, Kastamonu wet, Göce, Immigrant, Cranberries, Dough, Meat, Milk, Grape, Lump, Wheat Tarhana and tarhana with minced meat, turnip and beet (Coşkun 2014; Gok, 2021).

The composition of tarhana changes with different formulations. Basically, it is prepared from wheat flour, yoghurt, different vegetables (tomato and paprika, or their pastes), salt, herbs, and spices. The ratio of yoghurt to wheat flour is usually 0.5:1 or 1:1. In some regions, the yoghurt content may be reduced or replaced with milk, and one or more of the following ingredients may be used: egg, soybean, corn, barley and rye flour, chickpea, lentils, cornelian cherry, and baker's yeast (*Sc. cerevisiae*) (Koca et al. 2015; Ovando-Martinez et al. 2014; Ozdemir et al. 2007). Increasing the amount of yoghurt in a tarhana formulation leads to an increase in the total lactic acid bacteria (LAB) count before and after fermentation, which also results in elevated lactic acid levels in the final product (Ozdemier et al. 2007). The fermentation period varies from 1 d to 1 week according to the desired properties. If a sour taste is preferred, the fermentation is prolonged. LAB in yoghurt and yeast are responsible for acid formation during fermentation and the leavening effect. After maturation, the dough is divided into small portions and sun-dried. During natural drying, exposure to direct sunlight is avoided because the color becomes pale and the quality of the product decreases. Oven drying is generally conducted at 55 °C for 72 h. When the dough is dry (does not stick to the hand), it is crumbled, sieved, and powder form of tarhana is obtained (Çelik et al. 2010; Ekinci and Kadakal 2005; Kıvanc and Funda 2017).

Traditional tarhana is in the dough-form after fermentation and can be used without drying. This form is called wet tarhana. If the dough is dried under the sun or in a dryer, it is called dry tarhana. Dry tarhana may be in a nugget, sheet, or powder form (Certel et al. 2007Erbaş et al. 2006). Tarhana is also prepared as a snack in the form of "tarhana chips" (Yıldırım and Güzeler 2016). Powdered tarhana is used as breadcrumb for coating the red or white meat before frying. Erbaş et al. (2006) concluded that wet tarhana has better sensory and some nutritional properties than dry tarhana since drying reduces some nutritional aspects, e.g., by lowering the amount of some organic acids compared to wet tarhana. Wet tarhana can be stored up to 6 months after refrigeration. Dry tarhana can be stored up to 2 years without refrigeration (Dalgic and Belibagli 2008).

Tarhana is a semi-ready food, can be cooked easily in a short time, and can be consumed as soup at breakfast, lunch, or dinner. It is mixed with cold water (1:1) and allowed to hydrate for 30 min. The thawed tarhana is cooked in water (1:4). Typically, meat or vegetable stock is used as the cooking water to increase both the flavor and nutritional value. For flavoring, sautéed tomato or paste, garlic, and some seasoning is added to the cooking water, and the ingredients are boiled together.

The average composition of tarhana has been determined as 10.2% (w/w) moisture, 16% protein, 60.9% carbohydrates, 5.4% fat, 1% crude fiber, 3.8% salt, and 6.2% ash (Dağlıoğlu 2000; Ibanoğlu et al. 1995; Kabak and

Dobson 2011; Ozdemir et al. 2007; Tamer et al. 2007). Tarhana is a good source of total minerals that are readily bioavailable (Ca, Mg, Zn, and K). With an increasing acidity and phytase activity in the fermentation medium, the total amount of minerals and proteins increases as a result of phytic acid fermentation loss (Ozdemir et al. 2007). Tarhana contains such minerals as calcium (109 mg/100 g), magnesium (78 mg/100 g), potassium (114 mg/100 g), and copper (450 mg/100 g) (Dağlıoğlu 2000). Dried tarhana prepared from yoghurt inoculated with different concentrations of probiotic culture (0.5–4.5%) has a protein content ranging between 18–20% (Dağlıoğlu 2000; Ibanoğlu et al. 1995). The lowest protein content (6.77%) has been reported for a sample containing cornelian cherry instead of yoghurt (Tamer et al. 2007). Seven water-soluble vitamins—ascorbic acid, niacin, pantothenic acid (vitamin B5), pyridoxine (vitamin B6), thiamine (vitamin B1), folic acid, and riboflavin (vitamin B2)—have been detected in commercially produced tarhana (Ekinci and Kadakal 2005).

Turkish Standardization Institute categorized tarhana into four types based on the method of production used. These are "flour tarhana," "goce tarhana," "semolina tarhana," and "mixed tarhana." The sensory properties of tarhana are affected by the type of ingredients used and fermentation, which is preformed by yoghurt bacteria, such as *Lb. bulgaricus* and *Streptococcus* (*St.*) *thermophilus*, and *Sc. cerevisiae*. It has a slightly sour taste with a strong yeast flavor because of lactic acids and some organic compounds produced by LAB and yeast. Two types of fermentation (alcohol and lactic acid fermentation) occur concurrently and are catalyzed by the microorganisms from yoghurt, baker's yeast, or sourdough. The yeast and LAB produce ethanol, carbon dioxide, and lactic acid, as well as other fermentation products, e.g., aldehydes, ketones, and different organic acids. Tarhana fermentation lasts 1–7 d (Dağlıoğlu et al. 2000; Ibanoğlu et al. 1995; Işık and Yapar 2012; Kumral 2015). In some fermentations, sourdough is used (Şimşek et al. 2017).

It has been reported that during tarhana fermentation, as a result of LAB activity in fermenting tarhana, levels of the following increase: amino acids, such as valine, methionine, tryptophan, alanine, isoleucine/leucine, phenylalanine, arginine, proline, and lysine; water-soluble vitamins, such as riboflavin, thiamine, niacin, pyridoxine, and folic acid; organic acids, such as lactic acid, acetic acid, propionic acid, and pyruvic acid (Kabak and Dobson 2011; Ozdemir et al. 2007; Gok 2021). Because of its high nutritive value and easy digestibility, tarhana is preferentially used for feeding babies, children, the elderly, and ailing individuals (Coşkun 2014; Dağlıoğlu 2000; Ekinci and Kadakal 2005; Erbaş et al. 2006; Gabrial et al. 2010; Ibanoğlu et al. 1995; Koca et al. 2006; Kıvanc and Funda 2017; Ozdemir et al. 2007; Sengun et al. 2009; Tamer et al. 2007). Tarhana formulations prepared from cornelian cherry and blackthorn fruits are less well known, have a sour taste, and are consumed locally, mostly by people who are sick.

Fermentation of tarhana leads to protein breakdown as a result of the proteolytic activity of LAB and yeast, which increases protein digestibility (Bilgiçli et al. 2006; Dağlıoğlu et al. 2002; Ibanoğlu et al. 1995; Işık and Yapar 2012). The produced organic acids and bacteriocins, low pH (3.8–4.4), and low moisture (6–11%) content have a bacteriostatic effect on pathogens and spoilage microorganisms during long-term storage of tarhana powder and extend the

shelf life. Lactic acid is the dominant organic acid in tarhana. Organic acids, mainly lactic acid and acetic acid, produced by LAB are effective antimicrobial agents, and they reduce the pH of food to prevent the growth of hazardous food microorganisms (Magala et al. 2013).

Tomato and paprika, or their pastes used in the original tarhana recipes enhance the functional properties of tarhana because of biologically active compounds and dietary fibers that they contain. Examples of such enhancing compounds in the tomato are lycopene, phenolics, organic acids, vitamins, and many other beneficial components, e.g., dietary fiber, pectin, oil, and protein in the pulp, seed, and skin (Lu et al. 2019).

The antimicrobial properties of tarhana were investigated by Dağlıoğlu et al. (2002). A tarhana dough mixture was inoculated with *Escherichia coli* and *Staphylococcus* (*S.*) *aureus*. After fermentation, these pathogens could not survive, and their viability decreased because of a combined effect of fermentation products, such as organic acids and ethanol, and the NaCl used (Dağlıoğlu et al. 2002). The production of a natural, safe, and healthy food in which lactic acid fermentation exerts an important biopreservative effect is paramount. LAB and their metabolites act as biopreservatives in foods. LAB can be used in cereal food products because of its ability to detoxify mycotoxins and phytase production (Andrabi et al. 2016; Kıvanc and Funda 2017).

The amount of essential amino acids, such as threonine, lysine, and tryptophan, is low in cereals. Further, cereal protein digestibility is also very low because of the presence of phytic acid, tannins, and polyphenols, which bind protein and render them indigestible. LAB fermentation of different cereals has been shown to effectively reduce the amount of phytic acid and tannins, as well as improve protein and mineral availability (Andrabi et al. 2016). During the fermentation of tarhana samples, reduction in the phytic acid levels was observed. It was attributed to the production of phytase and its activity in the fermenting mixture (Bilgiçli et al. 2006; Kumral 2015). *Lb. plantarum* present in the fermented product produces high levels of extracellular and intracellular phytase, which reduce phytate levels and enhance the bioavailability of various minerals, such as iron, manganese, and zinc (Sumengen et al. 2013). Tarhana produced with flour fortified with wheat germ and bran has a high phytic acid content before fermentation, which is considerably reduced after fermentation (Bilgiçli and İbanoğlu 2007).

Karakaya and El (1999), identified quercetin (5.092 mg/100 g) as the major flavonoid present in homemade tarhana. Black grape, red lettuce, and strawberry contain 2.15, 2.65, and 1.75 (mg/100 g) quercetin, respectively (D'Andrea 2015). These levels are lower than those determined in tarhana by Karakaya and El (1999). Quercetin levels in red onion (39 mg/100 g), common onion (20 mg/100 g), cranberry (15 mg/100 g), and blueberry (8 mg/100 g) are high compared to tarhana. Red onion can be used to increase the nutritive benefits of tarhana. There is growing new interest in the scientific community in flavonoids and their derivatives with diverse biological properties. The daily intake of quercetin in the common diet has been estimated to be 5–40 mg/d (Russo et al. 2012). In the Western diet, it is high and approximately 15 mg (D'Andrea 2015; Lesjak et al. 2018). Quercetin is one of the most often studied dietary flavonoids, and has great therapeutic potential for the prevention and

treatment of different chronic diseases, including cardiovascular and neurodegenerative diseases, as well as cancer (D'Andrea 2015; Lesjak et al. 2018). As a nutraceutical for functional foods, quercetin may be used within 0.008–0.5% or 10–125 mg/serving (D'Andrea 2015). Thus, tarhana may be one of the important sources for quercetin, as a food serving.

Sengun et al. (2009) studied eight different local tarhana samples and concluded that the composition of LAB during fermentation varies depending on the raw material, fermentation time, and techniques used in the production of tarhana.

Some studies were performed to enhance the functional properties of tarhana by using different cereal or legumes as the raw materials, different vegetables, and different probiotic bacteria for fermentation. Increasing the probiotic culture concentrations increased the number of probiotic bacteria in dried tarhana (Capela et al. 2006; Gabrial et al. 2010; Ibanoglu et al. 1999; Şimşek et al. 2017). In a study of Şimşek et al. (2017), homemade and commercial tarhana dough were fermented with sourdough.

Because of high nutritional value tarhana with natural, delicious, semi-ready form it was accepted as functional food and can be stored for a very long time without any food additives. It is a very important fermented product of Turkish cuisine culture and important winter food prepared by drying yoghurt in general, called "Kurut" in Central Asia (Coşkun, 2014; Gok, 2021). It is accepted that Turks and Mongols who migrated from Central Asia brought Tarhana to the Anatolia and spread to their close neighbors, such as Iraq, Iran and to the eastern and western countries such as Greece, Hungary, and Finland via Rumelia during the Ottoman Empire (Coşkun, 2014). Tarhana is consumed under different names in some countries like “Kishk” in Syria, Lebanon, Jordan, Palestine, and Egypt, “kushuk” in Iran and Iraq, “tahonyaltalkuna” in Hungary and Filland, “trahana” in Greece and “atole” in Scotland (Gok, 2021).

There are four types of tarhana recipes in the standards: "flour tarhana", "goce tarhana", "semolina tarhana" and "mixed tarhana". In general, tarhana may vary depend on the regions with variaotions in prepeartion (Coşkun, 2014). Today the most common tarhana is obtained by mixing flour with yoghurt, tomato, capia pepper, onion, mint and salt to form dough and allowed to ferment then dryed and powdered. There are also many various types of tarhana prepared in the different regions (Şimşek, et al., 2017; Kıvanç & Funda, 2017). Use of different raw materials and preparation techniques result in variability in fermentation and cause differences in taste, smell and nutritional value. Tarhana types found in the regions of our country show different characteristics from salty to sweet; Aegean tarhana, goce tarhana, ball tarhana, Thrace tarhana, white tarhana, Gediz tarhana, minced tarhana, kiren (cranberry) tarhana, Beyşehir tarhana, immigrant tarhana, Kastamonu wet tarhana, Sivas tarhana, Maraş tarhana, turnip tarhana, beet tarhana, milk tarhana, dough tarhana, meat tarhana, grape tarhana, sweet tarhana (Coşkun, 2014; Kıvanç and Funda, 2017).

Materials and Methods

This study is quantitative research from observational research methods, it is descriptive and cross-sectional, and methodologically exploratory. A questionnaire was prepared by using literature studies and consists of two parts. The first part includes sociodemographic questions. The second part consists of 22 questions

investigating the tarhana consumption attitude created by the researcher as a result of the literature review.

The questionnaire was named as "Questionnaire on Tarhana Consumption Attitudes" and five-point Likert type scale was used. The answers are "Strongly Disagree", "Disagree", "Netiher Agree Nor Disagree", "Agree" and "Strongly Agree". Due to the pandemic, data were collected online between November and December 2020 by simple random sampling method. The questionnaire form was created from the website www.onlineanketler.com.

The population of the research is chosen from an unknown population. The unknown population sample size calculation was used categorically to evaluate the outcome criterion. When the literature is examined, it is seen that the data is limited compared to tarhana consumption in Turkey. In the study conducted by Tümer et al. (2017) it was determined that the minimum rate for the consumption of tarhana chips were 31.8% (Tumer et al. 2017).

When this study and Cohen effect size standards are taken as reference, the sample sizes calculated separately with the G Power 3.1.9.4 program, with the view that the medium effect size should be 0.30, were found to be 310 (with an effect size of 0.318) and 348 (with an effect size of 0.300) (Jacob, 1992).

In calculating the sample, the margin of error for type 1 was 5% and margin of error for type 2 was taken as 95%. Accordingly, to ensure the validity of the research, the minimum sample size was determined as 348 people and data collection was terminated by reaching 356 people. As 4 questionnaires were incomplete, they were excluded from the analysis and the answers of 352 people were evaluated.

Data were analyzed using MS Excel 2016 and SPSS 22.0 programs. In the presentation of the analysis, descriptive statistical methods such as frequency, percentage, mean, standard deviation, lower and upper values were used. Chi-square analysis or likelihood ratio estimation, which is one of the probability estimation methods that should be selected by considering the ratio of the parameters representing the number of observations below 5 in the comparison analysis, was taken into consideration compared to the total number of parameters. In addition, considering the median parameter range and the 0.25-0.75 percentile, age groupings were formed as "23 years and under", "24-41 years" and "42 years and above".

Factor analysis

To group the items in the questionnaire created by the researcher under factors, exploratory factor analysis was used. Kaiser Meier Olkin and Bartlett sphericity test was applied to measure the suitability of sample adequacy for factor analysis. Principal components were selected and oblimin rotation method was used to explain the factors. The explanation of the factors was completed in 21 iterations, although the eigenvalue was left at 1 and the maximum number of iterations was left at 25 in order to interfere with the matrix trace at a minimum level. This situation shows that the data set and the prepared items are quite suitable for factor analysis.

Study Results and Discussion

The findings of the study include the participants' sociodemographic information, tarhana consumption

preferences, ideas about tarhana preparation, tarhana consumption patterns, information about tarhana content and attitudes towards tarhana.

Sociodemographic structure of the participants

The demographic characteristics of the research participants are as follows: 69.3% of the participants are women and 30.7% are men. 57.7% of them are single and 49.4% of them are between 24-41 years old (Figure 1).
The educational status of the participants is as follows.74.4% of the participants are university graduates, 18.8% are high school graduates, 4% are secondary school graduates and 2.8% are primary school graduates. While the rate of private sector employees among the participants is 30.7%, 28.4% are students and 15.9% are not working.
It was observed that 27.8% of them had a monthly income of 0-1000 TL, 23% had a monthly income of 5000 TL or more, 21.6% had a monthly income of 3001-500 TL, and 19.3% had a monthly income between 2001-3000 TL (Figure 1).
The average age of the participants is 32.36±12.01, a high percentage of them are university graduates and their monthly income is over 3000 TL. This result shows that the Participants are economically independent when making their choices.

"Figure 1"

factor analysis

In the factor analysis based on the answers given to the questions measuring the preferences and attitudes of tarhana consumers, it was determined that the items were gathered under 6 groups (factors)

As a result of the KMO and Bartlett sphericity test, the KMO value was found to be 0.833, and the sphericity result was found to be significant ($p=0.000<0.05$). It was seen that the factors created by taking the eigenvalue as a minimum of 1 consisted of 6 factors and explained 61,108% of the total variance.

"Table 1"
"Table 2"

When the factor loading difference was evaluated by considering the 0.10 threshold value, it was seen that only two items (S6 and S16) loaded on more than one factor. In this case, it was thought that the prepared questionnaire could be used as a scale in a more comprehensive study.
The first factor consists of 7 items (S12, S17, S18, S19, S20, S21, S22) measuring "Tradition-Storability-Promotion" and the Factor eigenvalue was calculated as 6,224 and it was found that it explained 28.292% of the variance.
The second factor consists of 4 items (S4, S5, S8, S9). It was named as "Tarhana as a Snack" considering the ingredients. The factor eigenvalue was 2.185 explaining 9.931% of the variance.
The third factor is the factor that measures the phenomenon of "liking" and consists of 2 items (S2, S3). The factor eigenvalue was 1.475 and explained 6.706% of the variance.
The fourth factor is the factor that measures "Preparation and Consumption as Main Meal" and consists of 2 questions (S7, S15). Its eigenvalue was calculated as 1,367 and it was seen that it explained 6,213% of the variance.
The fifth factor consisted of 5 items (S1, S6, S10, S11, S16). The items and their loads were evaluated and determined as the "Being Healthy" factor. In naming, it was thought that those with higher factor

loads were dominant. The eigenvalue is 1.184, and the explained variance is 5.380%.
The sixth and last factor consists of 2 items (S13, S14). It is named as "Consumption Attitude" according to the expressions of the items. The factor eigenvalue is 1.009 and the explained variance is 4.585%.

"Effecet of Traditionality, storability and promotion in tarhana consumption" factor

172 (48.9%) of the participants "strongly agree" with the opinion "Tarhana can be consumed in all seasons" and 226 (64.2%) answered "I strongly agree" with the statement "Tarhana is a traditional product". This is the most agreed item between the participants.
202 (57.4%) people said, "I strongly agree" to "Tarhana can be stored dry", 207 (58.8%) people said, "I strongly agree" to "Tarhana can be stored for a long time" and 225 (63.9%) people said, "I totally agree" to "Tarhana can be a national flavor with the right promotion" 183 (52.0%) respondents said, "I Strongly Agree" to the statement "Advertising tarhana on platforms such as TV and social media increases its consumption" and 206 (58.5%) participants said, "Strongly Agree" to the statement "Sales of tarhana in touristic places ensures its recognition"

"Tarhana as a snack" factor

While 96 (27.3%) participants said, "I agree" to "Tarhana can be consumed as nut snack", 122 participants (34.7%) said "Indecisive" to "Tarhana should be consumed as a snack food eaten between meals". This is the item that participants are most undecided about.
While 101 (28.7%) participants said, "I agree" to "Tarhana can be consumed as chips", 84 (23.9%) participants answered "disagree" to "I consume tarhana instead of chips".

"Liking" factor

194 (55.1%) people said, "strongly disagree" to the statement "I don't like the taste of tarhana". This was the most disagreed item, and to the statement "I do not like the smell of tarhana", 187 (53.1%) people answered, "I strongly disagree".

"Preparation and consumption as a main meal" factor

While 119 (33.8%) of the participants answered, "disagree" to the proposition "Tarhana should be consumed as a main meal alone", 89 (25.3%) people answered "Indecisive" to "Tarhana is prepared using herbal and animal products".

"Being healthy" factor

161 (45.7%) and 191 (54.3%) participants said, "strongly agree" to "I know about tarhana" and "Tarhana should be consumed as soup", respectively.
225 participants (63.9%) "Strongly Agree" with the statement "Tarhana consumption is beneficial for health" and 202 (57.4%) participants "Strongly Agree" with the statement "Tarhana is a functional (health-supporting) product". Lastly, 145 (41.2%) people said, "strongly agree" with the statement "Fermentation method is used in making tarhana"

"Consumption Attitude" factor

220 people (62.5%) said "strongly agree" to the statement "I consume tarhana as home made" and 153 (43.5%) participants answered "disagree" to the statement "I buy tarhana from the market"

Comparison of Independent Qualitative Variables with Items

The items related to tarhana consumption attitudes of consumers were compared with gender, marital status, age groups, educational status, occupational status, and income status.

Tarhana consumption attitudes by gender

When Table 3 is examined, it is seen that gender is effective in the consumption attitude of tarhana. A significant difference ($p<0.05$) was found between the genders in the answers given by the participants to the following propositions: "Tarhana can be consumed as a snack", "Tarhana should be consumed as a main meal alone", "Tarhana can be consumed in all seasons", "Fermentation method is used in making tarhana", "Tarhana can be stored for a long time", "Tarhana can be a national flavor with the right promotion", "Advertising of tarhana places , like TV and social media increases its consumption", "Selling tarhana in touristic places ensures its recognition".

However, no significant relationship was found between the genders in the answers given to the other questions ($p>0.05$). According to the results obtained, we can think that women are more interested and knowledgeable in the consumption of tarhana than men, that they can contribute to different consumption trends such as snacks instead of soup, and that they can increase the consumption diversity of tarhana. In addition to these, we can conclude that by increasing the consumption of tarhana by women, tarhana can go beyond the local and contribute to it becoming a national flavor.

"Table 3"

Tarhana consumption attitudes according to marital status

There was a significant difference between the participants for item "I have knowledge about Tarhana" and their marital status ($p<0.05$). Married people agree with this view more than single people (Table 4).

"Table 4"

Tarhana consumption attitudes by age groups

A significant difference was found between the answers given by the participants to the item "I have knowledge about Tarhana" and the age groups ($p<0.05$). It was observed that the rate of agreeing with this opinion of the older age groups was higher than those of the younger age groups (Table 5). A significant difference was found between the answers given by the participants to the item "I know about Tarhana" and the age groups ($p<0.05$). It was observed that the rate of agreeing with this opinion of the older age groups was higher than those of the younger age groups.

"Table 5"

There was no significant difference between age groups in their views on whether tarhana can be consumed as a main dish alone or as chips, bought from the market and sold in order to be recognized in touristic places ($p>0.05$) (Table 5)

Tarhana consumption attitudes according to education level

A significant difference was found between the answers given by the participants to the statement "I don't like the taste of tarhana" and their

educational status ($p<0.05$) (Table 6). It has been found that primary and secondary school graduates agree with this view less than those at other education levels.
There is a significant difference between the responses given to the items "Tarhana can be consumed as a snack", "Tarhana can be consumed as chips", "I consume tarhana instead of chips", "Tarhana is a functional (health-supporting) product" ($p<0.05$). University and high school graduates are the education group that gives the answer "Strongly Agree" with the highest rate. As the education level decreased, the preference for consuming tarhana as a snack decreased.

"Table 6"

Tümer et al. (2017) in their study to determine the behavior of 384 consumers living in Maraş regarding the consumption of Maraş tarhana in 2017, it was found that the tendency to consume Maraş tarhana chips instead of potato chips decreased as the age and income level increased, older age groups and those with high income levels preferred potato chips more. And, likewise, with the increase in the level of education, it was concluded that the participants preferred Maraş tarhana more than potato chips (Tümer et al. 2017).

In the research conducted by Öncebe and Demircan (2019), it was stated that the education level of consumers is effective in the consumption of functional foods (Öncebe and Demirci, 2019). As a result of this study, it is seen that the evaluation of tarhana outside of soup, which is the traditional consumption form, is accepted as the education level increases.

It can be concluded that the innovative use of tarhana in different recipes apart from soup is an alternative for those who do not want to consume it as soup, as well as contributing to increasing the consumption of tarhana, removing it from the perception of a local product, and making it ready for consumption at any time in packaged products such as chips

Tarhana consumption attitudes according to occupational status

The responses of the participants to the statement "I know about Tarhana" differed significantly according to their professional status ($p<0.05$) (Table 7). Employed, unemployed, retired, and other groups agreed with the statement "I know about tarhana" more than students.

"Table 7"

However, there was no significant difference between the occupational status of the participants and the following statements: "I don't like the taste of tarhana", "I don't like the smell of tarhana", "Tarhana should be consumed alone as a main meal", "Tarhana consumption is beneficial for health", "Tarhana is a functional product" (health-supporting product), "I buy tarhana from the market", "Fermentation method is used in making tarhana", and "Tarhana is a traditional product"
The taste and smell of tarhana is generally appreciated by participants from all professions. It has been approved by every professional group that "it can be consumed alone as a main meal", "homemade tarhana is preferred", "it is a functional and traditional fermented product beneficial to health". There was no significant difference between these propositions and occupational groups ($p>0.05$).

Tarhana consumption attitudes according to income status

A significant difference was found between the answers given by the participants to the item "I know about Tarhana" and their income status ($p<0.05$) (Table 8). It is seen that those with a high-income level agree with this view more than those with a lower income level

"Table 8"

While the taste and smell of tarhana was not liked by the participants with high income level, they stated that they could consume it "as nut snack" and "as a snack food eaten between meals" instead of chips. Although all income groups mostly approve that it is a useful and functional product in terms of health, it was accepted by the majority of the participants with high income levels.

The increase in the income level of the participants who preferred to consume homemade tarhana instead of buying it from the market created a significant difference ($p<0.05$). As the income level increased, the preference for homemade tarhana consumption increased.

Conclusion and Recommendations

As a result, it has been determined that the participants have general knowledge about tarhana and that tarhana is seen as a local product. It has been concluded that the sensory characteristics such as taste and smell and the way of consumption also change the consumer attitude in the use of tarhana, and its consumption is not common in rural areas except for soup. It has been determined that consumers have information about the production and storage conditions of tarhana, which they see as a healthy meal.

It was determined that the sociodemographic structure of the participants was effective on the sensory characteristics such as taste and smell in the consumption of tarhana and the way of consumption, and it was observed that the participants had a certain level of knowledge about the production and storage conditions.

Although tarhana has nutritional values and taste, it has remained mostly local. Tarhana has an important gastronomic value, its consumption areas should be expanded with different shapes and ingredients other than soup, and it should be evaluated both in terms of promotion of the country and economic benefit. Tarhana, a traditional fermented instant soup, can find its place in international markets as a functional food.

The functional product market in the world developed rapidly after 1980 and countries with large economies such as Japan and the USA made significant gains from this market. In Turkey too, the functional product market has been developing rapidly in recent years (Gök and Ulu, 2019).

While many countries are trying to create and market functional products, there are already countless local products such as tarhana that have proven themselves for centuries in terms of health. Studies should be carried out to promote tarhana as a functional product rather than a local product. In order to reach the goal with the information obtained, it is necessary to increase the consumption of tarhana by giving individuals the habit of consuming tarhana at a younger age. It is also thought that it should be promoted in order to raise awareness and increase tarhana consumption.

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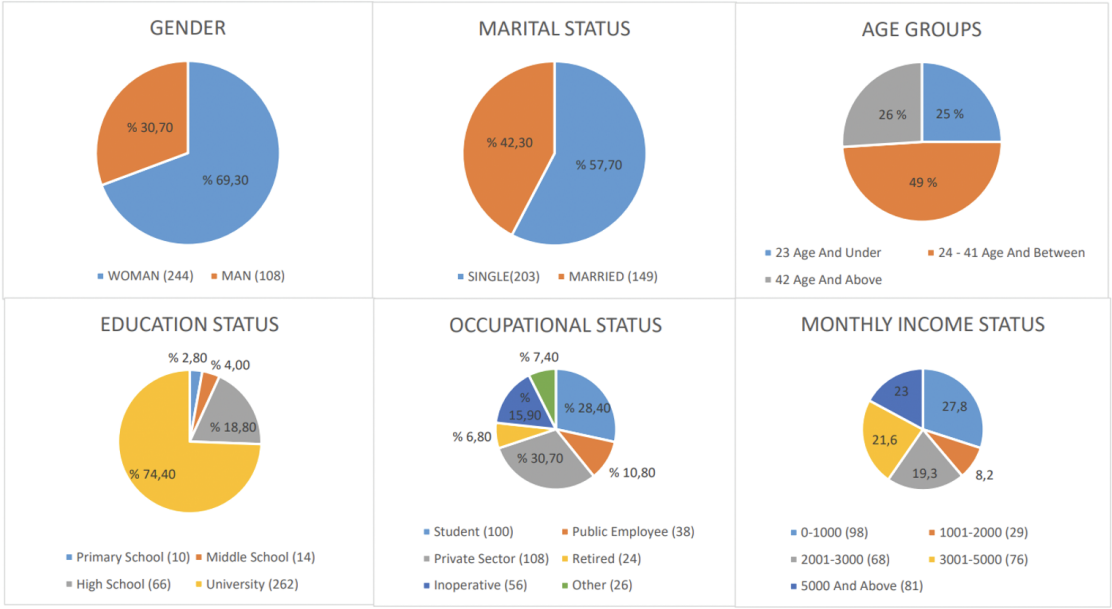

Table 1. Factor Analysis

No	Değişkenler	x̄	Faktör 1	Faktör 2	Faktör 3	Faktör 4	Faktör 5	Faktör 6	Ext.
S1	Tarhana information	4.17	*0.121*	*0.125*	*-0.126*	*0.095*	**0.533**	*0.035*	0.429
S2	Enjoy the taste	1.92	*-0.034*	*-0.033*	**0.856**	*-0.054*	*-0.030*	*0.050*	0.787
S3	Liking the smell	1.83	*0.024*	*0.000*	**0.920**	*0.035*	*0.070*	*-0.011*	0.811
S4	İt can be a cookie	3.06	*-0.118*	**0.887**	*-0.058*	*0.049*	*0.039*	*-0.022*	0.769
S5	İt can be a dec meal	3.16	*-0.015*	**0.408**	*0.018*	*-0.516*	*-0.054*	*-0.037*	0.458
S6	Consumption as a soup	4.38	*0.061*	*-0.220*	*-0.121*	*-0.324*	**0.402**	*-0.088*	0.400
S7	The fact that it can be main meal alone	3.12	*0.238*	*0.147*	*0.063*	**-0.430**	*-0.076*	*-0.436*	0.492
S8	Chips can be	3.23	*0.032*	**0.873**	*0.032*	*0.104*	*0.076*	*0.094*	0.758
S9	Choosing tarhana istead of chips	2.99	*0.175*	**0.482**	*-0.181*	*-0.351*	*0.039*	*0.032*	0.521
S10	Be healty – or healty	4.53	*-0.020*	*0.030*	*0.075*	*0.081*	**0.875**	*0.007*	0.725
S11	Be a functional product	4.47	*-0.053*	*0.040*	*-0.037*	*-0.107*	**0.850**	*-0.077*	0.749
S12	İt can be consumed in all seasons	4.19	**0.408**	*0.049*	*0.073*	*-0.098*	*0.349*	*-0.092*	0.463
S13	It should be homemade	4.48	*0.173*	*-0.010*	*-0.018*	*-0.039*	*0.232*	**-0.642**	0.673
S14	Be available at the grocery store	2.01	*0.141*	*0.119*	*0.092*	*-0.116*	*-0.018*	**0.813**	0.675
S15	Vegetable and animal preparedness	3.31	*0.156*	*0.215*	*0.011*	**0.553**	*-0.026*	*-0.180*	0.426
S16	fermentation can be used in the production of	4.05	*0.170*	*0.017*	*-0.036*	*0.364*	**0.429**	*-0.251*	0.571
S17	being a traditional product	4.57	**0.518**	*0.022*	*-0.198*	*0.152*	*0.185*	*-0.046*	0.541
S18	it can be stored dry	4.36	**0.581**	*-0.120*	*-0.008*	*-0.175*	*0.167*	*0.205*	0.460
S19	it can be stored for a long time	4.43	**0.732**	*0.029*	*0.069*	*0.131*	*0.066*	*-0.051*	0.598
S20	Ulusal lezzet olabilirliği	4.52	**0.810**	*-0.044*	*-0.047*	*-0.001*	*0.011*	*-0.071*	0.713
S21	Consumption may increase with advertising	4.34	**0.865**	*0.033*	*-0.103*	*0.048*	*-0.108*	*0.012*	0.728
S22	It can be sold in tourist places for recognition	4.46	**0.853**	*0.020*	*-0.002*	*0.016*	*-0.075*	*-0.038*	0.697
	Özdeğer		**6.224**	**2.185**	**1.475**	**1.367**	**1.184**	**1.009**	
	Varyans variance		**28.292**	**9.931**	**6.706**	**6.213**	**5.380**	**4.585**	
	Kümülatif Varyans cumulative variance		**28.292**	**38.223**	**44.929**	**51.142**	**56.522**	**61.108**	

χ2: 2857.516; KMO=0.833; df=231; p=0.000

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Table 2. Data on the participants attitude to tarhana consumption

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree	
		N	%	n	%	n	%	n	%	n	%
S1	I have information about tarhana .	12	*3.4*	14	*4.0*	37	*10.5*	128	*36.4*	**161**	***45.7***
S2	I don't like the taste of tarhana	**194**	***55.1***	75	*21.3*	20	*5.7*	43	*12.2*	20	*5.7*
S3	I don't like the smell of tarhana .	**187**	***53.1***	88	*25.0*	36	*10.2*	33	*9.4*	8	*2.3*
S4	Tarhana can be consumed as a snack	54	*15.3*	72	*20.5*	77	*21.9*	**96**	***27.3***	53	*15.1*
S5	Tarhana should be consumed as a dec meal .	27	*7.7*	63	*17.9*	**122**	***34.7***	106	*30.1*	34	*9.7*
S6	Tarhana should be consumed as a soup.	7	*2.0*	12	*3.4*	11	*3.1*	131	*37.2*	**191**	***54.3***
S7	Tarhana alone should be consumed as the main meal.	13	*3.7*	119	***33.8***	**85**	*24.1*	82	*23.3*	53	*15.1*
S8	tarhana can be consumed as chips.	44	*12.5*	69	*19.6*	69	*19.6*	**101**	***28.7***	69	*19.6*
S9	I consume tarhana instead of chips.	61	*17.3*	**84**	***23.9***	66	*18.8*	79	*22.4*	62	*17.6*
S10	Consumption of tarhana is beneficial for health.	4	*1.1*	5	*1.4*	16	*4.5*	102	*29.0*	**225**	***63.9***
S11	Tarhana is a functional (health-promoting) product.	0	*0.0*	5	*1.4*	25	*7.1*	120	*34.1*	**202**	***57.4***
S12	Tarhana can be consumed in all season.	6	*1.7*	24	*6.8*	39	*11.1*	111	*31.5*	**172**	***48.9***
S13	I consume tarhana homemade	1	*0.3*	12	*3.4*	23	*6.5*	96	*27.3*	**220**	***62.5***
S14	I buy the tarhana at the grocery store and consume it.	116	*33.0*	**153**	***43.5***	51	*14.5*	27	*7.7*	5	*1.4*
S15	Tarhana is prepared using vegetable and animal products.	45	*12.8*	50	*14.2*	**89**	***25.3***	86	*24.4*	82	*23.3*
S16	Fermentation method is used in the production of tarhana.	5	*1.4*	18	*5.1*	78	*22.2*	106	*30.1*	**145**	***41.2***
S17	Tarhana is a traditional product.	3	*0.9*	5	*1.4*	8	*2.3*	110	*31.3*	**226**	***64.2***
S18	tarhana is stored dry.	5	*1.4*	21	*6.0*	19	*5.4*	105	*29.8*	**202**	***57.4***
S19	Tarhana can be stored for a long time.	2	*0.6*	9	*2.6*	31	*8.8*	103	*29.3*	**207**	***58.8***
S20	Tarhana can become a national delicacy with the right introduction.	5	*1.4*	6	*1.7*	16	*4.5*	100	*28.4*	**225**	***63.9***
S21	The Tv of Tarhana. advertising in places such as social media increases consumption.	2	*0.6*	10	*2.8*	38	*10.8*	119	*33.8*	**183**	***52.0***
S22	The sale of tarhana in tourist places allows it to be recognized.	2	*0.6*	6	*1.7*	25	*7.1*	113	*32.1*	**206**	***58.5***

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Table 3. Tarhana consumption attitudes of the participants according to their gender (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2
		n	%	n	%	n	%	n	%	n	%	p
S1	Woman	9	3.7	9	3.7	24	9.8	93	38.1	109	44.7	1.562[b] 0.814
	Male	3	2.8	5	4.6	13	12.0	35	32.4	52	48.1	
S2	Woman	138	56.6	51	20.9	14	5.7	25	10.2	16	6.6	3.966[a] 0.411
	Male	56	51.9	24	22.2	6	5.6	18	16.7	4	3.7	
S3	Woman	123	50.4	64	26.2	27	11.1	23	9.4	7	2.9	3.377[a] 0.497
	Male	64	59.3	24	22.2	9	8.3	10	9.3	1	0.9	
S4	Woman	25	10.2	47	19.3	59	24.2	74	30.3	39	16.0	**19.117[a] 0.001***
	Male	29	26.9	25	23.1	18	16.7	22	20.4	14	13.0	
S5	Woman	17	7.0	42	17.2	92	37.7	71	29.1	22	9.0	3.462[a] 0.484
	Male	10	9.3	21	19.4	30	27.8	35	32.4	12	11.1	
S6	Woman	4	1.6	7	2.9	10	4.1	86	35.2	137	56.1	4.931[b] 0.295
	Male	3	2.8	5	4.6	1	0.9	45	41.7	54	50.0	
S7	Woman	5	2.0	75	30.7	63	25.8	63	25.8	38	15.6	**11.273[a] 0.024***
	Male	8	7.4	44	40.7	22	20.4	19	17.6	15	13.9	
S8	Woman	27	11.1	42	17.2	47	19.3	74	30.3	54	22.1	7.007[a] 0.136
	Male	17	15.7	27	25.0	22	20.4	27	25.0	15	13.9	
S9	Woman	40	16.4	55	22.5	52	21.3	53	21.7	44	18.0	4.032[a] 0.402
	Male	21	19.4	29	26.9	14	13.0	26	24.1	18	16.7	
S10	Woman	4	1.6	2	0.8	9	3.7	73	29.9	156	63.9	5.319[b] 0.256
	Male	0	0.0	3	2.8	7	6.5	29	26.9	69	63.9	
S11	Woman	0	0.0	4	1.6	17	7.0	83	34.0	140	57.4	0.290[b] 0.962
	Male	0	0.0	1	0.9	8	7.4	37	34.3	62	57.4	
S12	Woman	2	0.8	15	6.1	33	13.5	70	28.7	124	50.8	**11.133[b] 0.025**
	Male	4	3.7	9	8.3	6	5.6	41	38.0	48	44.4	
S13	Woman	1	0.4	8	3.3	14	5.7	63	25.8	158	64.8	2.771[b] 0.597
	Male	0	0.0	4	3.7	9	8.3	33	30.6	62	57.4	
S14	Woman	83	34.0	105	43.0	33	13.5	21	8.6	2	0.8	3.597[b] 0.463
	Male	33	30.6	48	44.4	18	16.7	6	5.6	3	2.8	
S15	Woman	28	11.5	33	13.5	57	23.4	60	24.6	66	27.0	7.306[a] 1.121
	Male	17	15.7	17	15.7	32	29.6	26	24.1	16	14.8	
S16	Woman	2	0.8	13	5.3	46	18.9	71	29.1	112	45.9	**10.419[b] 0.034***
	Male	3	2.8	5	4.6	32	29.6	35	32.4	33	30.6	
S17	Woman	1	0.4	2	0.8	6	2.5	75	30.7	160	65.6	3.891[b] 0.421
	Male	2	1.9	3	2.8	2	1.9	35	32.4	66	61.1	
S18	Woman	3	1.2	17	7.0	15	6.1	70	28.7	139	57.0	2.911[b] 0.573
	Male	2	1.9	4	3.7	4	3.7	35	32.4	63	58.3	
S19	Woman	0.0	1	0.4	21	8.6	72	29.5	150	61.5	0.0	**19.119[b] 0.001***
	Male	1.9	8	7.4	10	9.3	31	28.7	57	52.8	1.9	
S20	Woman	1	0.4	2	0.8	13	5.3	70	28.7	158	64.8	**9.744[b] 0.045***
	Male	4	3.7	4	3.7	3	2.8	30	27.8	67	62.0	
S21	Woman	0	0.0	3	1.2	26	10.7	87	35.7	128	52.5	**12.121[b] 0.016***
	Male	2	1.9	7	6.5	12	11.1	32	29.6	55	50.9	
S22	Woman	0	0.0	1	0.4	19	7.8	76	31.1	148	60.7	**13.268[b] 0.010***
	Male	2	1.9	5	4.6	6	5.6	37	34.3	58	53.7	

***: p<0.05; [a]:Ki-kare test ; [b]:Likelihood ratio**

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Table 4. Tarhana consumption attitudes of the participants according to their marital status (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2
		n	%	n	%	n	%	n	%	n	%	p
S1	Single	5	*2.5*	10	*4.9*	31	*15.3*	80	*39.4*	77	*37.9*	**20.295** [a]
	Married	7	*4.7*	4	*2.7*	6	*4.0*	48	*32.2*	84	*56.4*	**0.000***
S2	Single	103	*50.7*	53	*26.1*	13	*6.4*	26	*12.8*	8	*3.9*	**9.990**[a]
	Married	91	*61.1*	22	*14.8*	7	*4.7*	17	*11.4*	12	*8.1*	**0.041***
S3	Single	94	*46.3*	61	*30.0*	24	*11.8*	22	*10.8*	2	*1.0*	**15.081** [b]
	Married	93	*62.4*	27	*18.1*	12	*8.1*	11	*7.4*	6	*4.0*	**0.005***
S4	Single	18	*8.9*	31	*15.3*	52	*25.6*	65	*32.0*	37	*18.2*	**29.632** [a]
	Married	36	*24.2*	41	*27.5*	25	*16.8*	31	*20.8*	16	*10.7*	**0.000***
S5	Single	9	*4.4*	29	*14.3*	85	*41.9*	60	*29.6*	20	*9.9*	**17.313** [a]
	Married	18	*12.1*	34	*22.8*	37	*24.8*	46	*30.9*	14	*9.4*	**0.002***
S6	Single	6	*3.0*	7	*3.4*	9	*4.4*	90	*44.3*	91	*44.8*	**20.004** [b]
	Married	1	*0.7*	5	*3.4*	2	*1.3*	41	*27.5*	100	*67.1*	**0.000***
S7	Single	6	*3.0*	68	*33.5*	52	*25.6*	48	*23.6*	29	*14.3*	1.362[a]
	Married	7	*4.7*	51	*34.2*	33	*22.1*	34	*22.8*	24	*16.1*	0.851
S8	Single	17	*8.4*	36	*17.7*	42	*20.7*	60	*29.6*	48	*23.6*	**11.797** [a]
	Married	27	*18.1*	33	*22.1*	27	*18.1*	41	*27.5*	21	*14.1*	**0.019***
S9	Single	36	*17.7*	51	*25.1*	48	*23.6*	33	*16.3*	35	*17.2*	**14.711** [a]
	Married	25	*16.8*	33	*22.1*	18	*12.1*	46	*30.9*	27	*18.1*	**0.005***
S10	Single	2	*1.0*	2	*1.0*	13	*6.4*	71	*35.0*	115	*56.7*	**14.849** [b]
	Married	2	*1.3*	3	*2.0*	3	*2.0*	31	*20.8*	110	*73.8*	**0.005***
S11	Single	0	*0.0*	3	*1.5*	18	*8.9*	82	*40.4*	100	*49.3*	**13.430** [b]
	Married	0	*0.0*	2	*1.3*	7	*4.7*	38	*25.5*	102	*68.5*	**0.004***
S12	Single	4	*2.0*	17	*8.4*	35	*17.2*	65	*32.0*	82	*40.4*	**28.572** [b]
	Married	2	*1.3*	7	*4.7*	4	*2.7*	46	*30.9*	90	*60.4*	**0.000***
S13	Single	1	*0.5*	5	*2.5*	21	*10.3*	58	*28.6*	118	*58.1*	**17.061** [b]
	Married	0	*0.0*	7	*4.7*	2	*1.3*	38	*25.5*	102	*68.5*	**0.002***
S14	Single	61	*30.0*	87	*42.9*	39	*19.2*	14	*6.9*	2	*1.0*	**10.174** [b]
	Married	55	*36.9*	66	*44.3*	12	*8.1*	13	*8.7*	3	*2.0*	**0.038***
S15	Single	18	*8.9*	26	*12.8*	63	*31.0*	51	*25.1*	45	*22.2*	**13.042** [a]
	Married	27	*18.1*	24	*16.1*	26	*17.4*	35	*23.5*	37	*24.8*	**0.011***
S16	Single	3	*1.5*	12	*5.9*	52	*25.6*	59	*29.1*	77	*37.9*	4.678[b]
	Married	2	*1.3*	6	*4.0*	26	*17.4*	47	*31.5*	68	*45.6*	0.322
S17	Single	0	*0.0*	2	*1.0*	5	*2.5*	75	*36.9*	121	*59.6*	**12.567** [b]
	Married	3	*2.0*	3	*2.0*	3	*2.0*	35	*23.5*	105	*70.5*	**0.014***
S18	Single	3	*1.5*	14	*6.9*	13	*6.4*	69	*34.0*	104	*51.2*	7.631[b]
	Married	2	*1.3*	7	*4.7*	6	*4.0*	36	*24.2*	98	*65.8*	0.106
S19	Single	0	*0.0*	2	*1.0*	24	*11.8*	63	*31.0*	114	*56.2*	**14.568** [b]
	Married	2	*1.3*	7	*4.7*	7	*4.7*	40	*26.8*	93	*62.4*	**0.006**
S19	Single	0	*0.0*	2	*1.0*	24	*11.8*	63	*31.0*	114	*56.2*	**14.568** [b]
	Married	2	*1.3*	7	*4.7*	7	*4.7*	40	*26.8*	93	*62.4*	**0.006**
S20	Single	0	*0.0*	2	*1.0*	12	*5.9*	69	*34.0*	120	*59.1*	**19.290** [a]
	Married	5	*3.4*	4	*2.7*	4	*2.7*	31	*20.8*	105	*70.5*	**0.001***
S21	Single	0	*0.0*	4	*2.0*	23	*11.3*	75	*36.9*	101	*49.8*	6.701[b]
	Married	2	*1.3*	6	*4.0*	15	*10.1*	44	*29.5*	82	*55.0*	0.153
S22	Single	0	*0.0*	1	*0.5*	14	*6.9*	64	*31.5*	124		8.348[b]
	Married	2	*1.3*	5	*3.4*	11	*7.4*	49	*32.9*	82		0.080

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Table 5. Tarhana consumption attitudes of the participants according to their age groups (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2 p
		n	%	n	%	n	%	n	%	n	%	
S1	23 and under	4	4.7	6	7.0	18	20.9	32	37.2	26	30.2	**29.284[b] 0.000***
	24-41 between	7	4.0	4	2.3	17	9.8	66	37.9	80	46.0	
	42 and above	1	1.1	4	4.3	2	2.2	30	32.6	55	59.8	
S2	23 and under	34	39.5	26	30.2	4	4.7	18	20.9	4	4.7	**21.365[a] 0.006***
	24-41 between	98	56.3	35	20.1	13	7.5	16	9.2	12	6.9	
	42 and above	62	67.4	14	15.2	3	3.3	9	9.8	4	4.3	
S3	23 and under	38	44.2	26	30.2	12	14.0	10	11.6	0	0.0	**18.573[b] 0.017***
	24-41 between	88	50.6	43	24.7	20	11.5	16	9.2	7	4.0	
	42 and above	61	66.3	19	20.7	4	4.3	7	7.6	1	1.1	
S4	23 and under	9	10.5	17	19.8	25	29.1	20	23.3	15	17.4	**34.997[a] 0.000***
	24-41 between	22	12.6	24	13.8	37	21.3	62	35.6	29	16.7	
	42 and above	23	25.0	31	33.7	15	16.3	14	15.2	9	9.8	
S5	23 and under	2	2.3	14	16.3	42	48.8	19	22.1	9	10.5	**27.671[a] 0.001***
	24-41 between	12	6.9	26	14.9	63	36.2	59	33.9	14	8.0	
	42 and above	13	14.1	23	25.0	17	18.5	28	30.4	11	12.0	
S6	23 and under	4	4.7	1	1.2	4	4.7	41	47.7	36	41.9	**22.681[b] 0.004***
	24-41 between	2	1.1	7	4.0	7	4.0	65	37.4	93	53.4	
	42 and above	1	1.1	4	4.3	0	0.0	25	27.2	62	67.4	
S7	23 and under	1	1.2	33	38.4	26	30.2	13	15.1	13	15.1	11.001[a] 0.202
	24-41 between	9	5.2	56	32.2	42	24.1	45	25.9	22	12.6	
	42 and above	3	3.3	30	32.6	17	18.5	24	26.1	18	19.6	

S8	23 and under	7	*8.1*	17	*19.8*	20	*23.3*	23	*26.7*	19	*22.1*	11.003 [a] 0.201
	24-41 between	20	*11.5*	28	*16.1*	35	*20.1*	55	*31.6*	36	*20.7*	
	42 and above	17	*18.5*	24	*26.1*	14	*15.2*	23	*25.0*	14	*15.2*	
		20	*23.3*	26	*30.2*	25	*29.1*	8	*9.3*	7	*8.1*	
S9	23 and under	30	*17.2*	38	*21.8*	34	*19.5*	40	*23.0*	32	*18.4*	**35.367** [a] **0.000***
	24-41 between	11	*12.0*	20	*21.7*	7	*7.6*	31	*33.7*	23	*25.0*	
	42 and above	0	*0.0*	0	*0.0*	8	*9.3*	37	*43.0*	41	*47.7*	
S10	23 and under	2	*1.1*	2	*1.1*	8	*4.6*	47	*27.0*	115	*66.1*	**32.622** [b] **0.000***
	24-41 between	2	*2.2*	3	*3.3*	0	*0.0*	18	*19.6*	69	*75.0*	
	42 and above	0	*0.0*	1	*1.2*	9	*10.5*	39	*45.3*	37	*43.0*	
S11	23 and under	0	*0.0*	1	*0.6*	14	*8.0*	56	*32.2*	103	*59.2*	**17.988** [b] **0.006***
	24-41 between	0	*0.0*	3	*3.3*	2	*2.2*	25	*27.2*	62	*67.4*	
	42 and above	1	*1.2*	9	*10.5*	39	*45.3*	37	*43.0*	1	*1.2*	
S12	23 and under	1	*0.6*	14	*8.0*	56	*32.2*	103	*59.2*	1	*0.6*	**47.151** [b] **0.000***
	24-41 between	3	*3.3*	2	*2.2*	25	*27.2*	62	*67.4*	3	*3.3*	
	42 and above	0	*0.0*	1	*1.2*	11	*12.8*	32	*37.2*	42	*48.8*	
S13	23 and under	1	*0.6*	6	*3.4*	11	*6.3*	35	*20.1*	121	*69.5*	**25.608** [b] **0.001***
	24-41 between	0	*0.0*	5	*5.4*	1	*1.1*	29	*31.5*	57	*62.0*	
	42 and above	22	*25.6*	38	*44.2*	15	*17.4*	10	*11.6*	1	*1.2*	
S14	23 and under	67	*38.5*	66	*37.9*	26	*14.9*	12	*6.9*	3	*1.7*	10.615 [b] 0.225
	24-41 between	27	*29.3*	49	*53.3*	10	*10.9*	5	*5.4*	1	*1.1*	
	42 and above	7	*8.1*	8	*9.3*	38	*44.2*	21	*24.4*	12	*14.0*	
S15	23 and under	24	*13.8*	29	*16.7*	37	*21.3*	40	*23.0*	44	*25.3*	**26.089** [a] **0.001***
	24-41 between	14	*15.2*	13	*14.1*	14	*15.2*	25	*27.2*	26	*28.3*	
	42 and above	2	*2.3*	7	*8.1*	28	*32.6*	30	*34.9*	19	*22.1*	
S16	23 and under	3	*1.7*	5	*2.9*	36	*20.7*	42	*24.1*	88	*50.6*	**29.690** [b] **0.000***
	24-41 between											

	42 and above	0	*0.0*	6	*6.5*	14	*15.2*	34	*37.0*	38	*41.3*	
	23 and under	0	*0.0*	0	*0.0*	1	*1.2*	48	*55.8*	37	*43.0*	
S17	24-41 between	1	*0.6*	2	*1.1*	7	*4.0*	40	*23.0*	124	*71.3*	**41.783** [b] **0.000***
	42 and above	2	*2.2*	3	*3.3*	0	*0.0*	22	*23.9*	65	*70.7*	
	23 and under	0	*0.0*	7	*8.1*	7	*8.1*	38	*44.2*	34	*39.5*	
S18	24-41 between	3	*1.7*	10	*5.7*	12	*6.9*	41	*23.6*	108	*62.1*	**30.238** [b] **0.000***
	42 and above	2	*2.2*	4	*4.3*	0	*0.0*	26	*28.3*	60	*65.2*	
	23 and under	0	*0.0*	0	*0.0*	17	*19.8*	35	*40.7*	34	*39.5*	
S19	24-41 between	0	*0.0*	4	*2.3*	12	*6.9*	48	*27.6*	110	*63.2*	**41.728** [b] **0.000***
	42 and above	2	*2.2*	5	*5.4*	2	*2.2*	20	*21.7*	63	*68.5*	
	23 and under	0	*0.0*	1	*1.2*	10	*11.6*	40	*46.5*	35	*40.7*	
S20	24-41 between	3	*1.7*	4	*2.3*	6	*3.4*	39	*22.4*	122	*70.1*	**41.545** [b] **0.000***
	42 and above	2	*2.2*	1	*1.1*	0	*0.0*	21	*22.8*	68	*73.9*	
	23 and under	0	*0.0*	3	*3.5*	17	*19.8*	39	*45.3*	27	*31.4*	
S21	24-41 between	0	*0.0*	5	*2.9*	21	*12.1*	52	*29.9*	96	*55.2*	**46.477** [b] **0.000***
	42 and above	2	*2.2*	2	*2.2*	0	*0.0*	28	*30.4*	60	*65.2*	
	23 and under	0	*0.0*	1	*1.2*	8	*9.3*	31	*36.0*	46	*53.5*	
S22	24-41 between	0	*0.0*	3	*1.7*	14	*8.0*	54	*31.0*	103	*59.2*	9.907[b] 0.272
	42 and above	2	*2.2*	2	*2.2*	3	*3.3*	28	*30.4*	57	*62.0*	

***: p<0.05; [a]:Ki-kare test ; [b]:Olabilirlik oranı**

Table 6. Tarhana consumption attitudes according to the trainings of the participants (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2 p
		n	%	N	%	n	%	n	%	n	%	
S1	Primary School	0	*0.0*	0	*0.0*	0	*0.0*	4	*40.0*	6	*60.0*	20.751 0.054
	Middle School	2	*14.3*	2	*14.3*	1	*7.1*	5	*35.7*	4	*28.6*	
	High School	1	*1.5*	6	*9.1*	6	*9.1*	17	*25.8*	36	*54.5*	
	University	9	*3.4*	6	*2.3*	30	*11.5*	102	*38.9*	115	*43.9*	
S2	Primary School	6	*60.0*	2	*20.0*	0	*0.0*	0	*0.0*	2	*20.0*	**16.323 0.010***
	Middle School	10	*71.4*	1	*7.1*	1	*7.1*	2	*14.3*	0	*0.0*	
	High School	30	*45.5*	12	*18.2*	1	*1.5*	16	*24.2*	7	*10.6*	
	University	148	*56.5*	60	*22.9*	18	*6.9*	25	*9.5*	11	*4.2*	
S3	Primary School	6	*60.0*	1	*10.0*	1	*10.0*	0	*0.0*	2	*20.0*	20.708 0.055
	Middle School	11	*78.6*	2	*14.3*	1	*7.1*	0	*0.0*	0	*0.0*	
	High School	33	*50.0*	12	*18.2*	8	*12.1*	11	*16.7*	2	*3.0*	
	University	137	*52.3*	73	*27.9*	26	*9.9*	22	*8.4*	4	*1.5*	
S4	Primary School	0	*0.0*	8	*80.0*	2	*20.0*	0	*0.0*	0	*0.0*	**55.487 0.000***
	Middle School	6	*42.9*	5	*35.7*	2	*14.3*	1	*7.1*	0	*0.0*	
	High School	16	*24.2*	20	*30.3*	13	*19.7*	11	*16.7*	6	*9.1*	
	University	32	*12.2*	39	*14.9*	60	*22.9*	84	*32.1*	47	*17.9*	
S5	Primary School	0	*0.0*	2	*20.0*	3	*30.0*	5	*50.0*	0	*0.0*	18.859 0.092
	Middle School	2	*14.3*	2	*14.3*	4	*28.6*	6	*42.9*	0	*0.0*	
	High School	10	*15.2*	15	*22.7*	20	*30.3*	13	*19.7*	8	*12.1*	
	University	15	*5.7*	44	*16.8*	95	*36.3*	82	*31.3*	26	*9.9*	
S6	Primary School	0	*0.0*	0	*0.0*	0	*0.0*	3	*30.0*	7	*70.0*	15.677 0.206
	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	6	*42.9*	8	*57.1*	
	High School	3	*4.5*	3	*4.5*	1	*1.5*	15	*22.7*	44	*66.7*	
	University	4	*1.5*	9	*3.4*	10	*3.8*	107	*40.8*	132	*50.4*	
S7	Primary School	0	*0.0*	3	*30.0*	1	*10.0*	4	*40.0*	2	*20.0*	16.867 0.155
	Middle School	0	*0.0*	2	*14.3*	1	*7.1*	5	*35.7*	6	*42.9*	
		2	*3.0*	26	*39.4*	15	*22.7*	12	*18.2*	11	*16.7*	
	University	11	*4.2*	88	*33.6*	68	*26.0*	61	*23.3*	34	*13.0*	
S8	Primary School	4	*40.0*	4	*40.0*	0	*0.0*	2	*20.0*	0	*0.0*	**40.525 0.000***
	Middle School	1	*7.1*	3	*21.4*	6	*42.9*	4	*28.6*	0	*0.0*	
	High School	13	*19.7*	20	*30.3*	14	*21.2*	12	*18.2*	7	*10.6*	
	University	26	*9.9*	42	*16.0*	49	*18.7*	83	*31.7*	62	*23.7*	
S9	Primary School	2	*20.0*	1	*10.0*	4	*40.0*	3	*30.0*	0	*0.0*	**25.175 0.014***
	Middle School	0	*0.0*	2	*14.3*	0	*0.0*	7	*50.0*	5	*35.7*	
	High School	10	*15.2*	19	*28.8*	10	*15.2*	14	*21.2*	13	*19.7*	
	University	49	*18.7*	62	*23.7*	52	*19.8*	55	*21.0*	44	*16.8*	
S10	Primary School	2	*20.0*	0	*0.0*	0	*0.0*	1	*10.0*	7	*70.0*	20.332 0.061
	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	2	*14.3*	12	*85.7*	
	High School	0	*0.0*	1	*1.5*	1	*1.5*	18	*27.3*	46	*69.7*	
	University	2	*0.8*	4	*1.5*	15	*5.7*	81	*30.9*	160	*61.1*	
S11	Primary School	0	*0.0*	0	*0.0*	3	*30.0*	7	*70.0*	7	*70.0*	**24.872 0.003***
	Middle School	0	*0.0*	0	*0.0*	1	*7.1*	13	*92.9*	12	*85.7*	
	High School	2	*3.0*	0	*0.0*	27	*40.9*	37	*56.1*	46	*69.7*	
	University	3	*1.1*	25	*9.5*	89	*34.0*	145	*55.3*	160	*61.1*	
S12	Primary School	0	*0.0*	0	*0.0*	0	*0.0*	4	*40.0*	6	*60.0*	16.437 0.172
	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	3	*21.4*	11	*78.6*	
	High School	0	*0.0*	5	*7.6*	7	*10.6*	24	*36.4*	30	*45.5*	
	University	6	*2.3*	19	*7.3*	32	*12.2*	80	*30.5*	125	*47.7*	
S13		0	*0.0*	0	*0.0*	0	*0.0*	3	*30.0*	7	*70.0*	10.261

	Primary School											0.593
	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	2	*14.3*	12	*85.7*	
	High School	0	*0.0*	1	*1.5*	5	*7.6*	22	*33.3*	38	*57.6*	
	University	1	*0.4*	11	*4.2*	18	*6.9*	69	*26.3*	163	*62.2*	
		4	*40.0*	5	*50.0*	1	*10.0*	0	*0.0*	0	*0.0*	
	Primary School											
S14	Middle School	4	*28.6*	9	*64.3*	1	*7.1*	0	*0.0*	0	*0.0*	10.101 0.607
	High School	21	*31.8*	27	*40.9*	8	*12.1*	9	*13.6*	1	*1.5*	
	University	87	*33.2*	112	*42.7*	41	*15.6*	18	*6.9*	4	*1.5*	
		4	*40.0*	0	*0.0*	1	*10.0*	1	*10.0*	4	*40.0*	
	Primary School											
S15	Middle School	2	*14.3*	3	*21.4*	5	*35.7*	2	*14.3*	2	*14.3*	17.889 0.119
	High School	9	*13.6*	12	*18.2*	20	*30.3*	16	*24.2*	9	*13.6*	
	Univrsity	30	*11.5*	35	*13.4*	63	*24.0*	67	*25.6*	67	*25.6*	
		0	*0.0*	1	*10.0*	1	*10.0*	2	*20.0*	6	*60.0*	
	Primary School											
S16	Middle School	0	*0.0*	0	*0.0*	1	*7.1*	7	*50.0*	6	*42.9*	11.473 0.466
	High School	2	*3.0*	5	*7.6*	18	*27.3*	19	*28.8*	22	*33.3*	
	University	3	*1.1*	12	*4.6*	58	*22.1*	78	*29.8*	111	*42.4*	
		0	*0.0*	0	*0.0*	0	*0.0*	4	*40.0*	6	*60.0*	
	Primary School											
S17	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	3	*21.4*	11	*78.6*	16.838 0.156
	High School	0	*0.0*	3	*4.5*	1	*1.5*	30	*45.5*	32	*48.5*	
	University	3	*1.1*	2	*0.8*	7	*2.7*	73	*27.9*	177	*67.6*	
		0	*0.0*	0	*0.0*	0	*0.0*	3	*30.0*	7	*70.0*	
	Primary School											
S18	Middle School	0	*0.0*	3	*21.4*	0	*0.0*	2	*14.3*	9	*64.3*	17.131 0.145
	High School	0	*0.0*	4	*6.1*	1	*1.5*	25	*37.9*	36	*54.5*	
	University	5	*1.9*	14	*5.3*	18	*6.9*	75	*28.6*	150	*57.3*	
		0	*0.0*	0	*0.0*	2	*20.0*	4	*40.0*	4	*40.0*	
S19	Primary School											20.691 0.055
	Middle School	0	*0.0*	1	*7.1*	0	*0.0*	1	*7.1*	12	*85.7*	
	Highschool	0	*0.0*	5	*7.6*	8	*12.1*	20	*30.3*	33	*50.0*	
	University	2	*0.8*	3	*1.1*	21	*8.0*	78	*29.8*	158	*60.3*	
		0	*0.0*	0	*0.0*	0	*0.0*	3	*30.0*	7	*70.0*	
	Primary School											
S20	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	1	*7.1*	13	*92.9*	15.742 0.203
	High School	0	*0.0*	1	*1.5*	1	*1.5*	25	*37.9*	39	*59.1*	
	University	5	*1.9*	5	*1.9*	15	*5.7*	71	*27.1*	166	*63.4*	
		0	*0.0*	0	*0.0*	2	*20.0*	4	*40.0*	4	*40.0*	
	Primary School											
S21	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	2	*14.3*	12	*85.7*	17.732 0.124
	High School	0	*0.0*	2	*3.0*	4	*6.1*	31	*47.0*	29	*43.9*	
	University	2	*0.8*	8	*3.1*	32	*12.2*	82	*31.3*	138	*52.7*	
		0	*0.0*	0	*0.0*	0	*0.0*	6	*60.0*	4	*40.0*	
	Primary School											
S22	Middle School	0	*0.0*	0	*0.0*	0	*0.0*	5	*35.7*	9	*64.3*	12.103 0.437
	High School	0	*0.0*	2	*3.0*	2	*3.0*	20	*30.3*	42	*63.6*	
	University	2	*0.8*	4	*1.5*	23	*8.8*	82	*31.3*	151	*57.6*	

***: p<0.05; [a]:Ki-kare test ; [b]:Olabilirlik oranı**

Table 7. Tarhana consumption attitudes of the participants according to their professional status (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2 p
		n	%	n	%	n	%	n	%	n	%	
	Student	5	5.0	6	6.0	17	17.0	38	38.0	34	34.0	
	Public Employee	2	5.3	0	0.0	3	7.9	13	34.2	20	52.6	
	Private Sector	0	0.0	3	2.8	13	12.0	35	32.4	57	52.8	**43.812** [b]
S1	Retired	0	0.0	4	16.7	2	8.3	7	29.2	11	45.8	**0.002***
	İnoperative	3	5.4	1	1.8	2	3.6	24	42.9	26	46.4	
	Other	2	7.7	0	0.0	0	0.0	11	42.3	13	50.0	
	Student	49	49.0	24	24.0	3	3.0	18	18.0	6	6.0	
	Public Employee	22	57.9	8	21.1	3	7.9	4	10.5	1	2.6	
	Private Sector	67	62.0	18	16.7	7	6.5	10	9.3	6	5.6	24.255 [b]
S2	Retired	14	58.3	4	16.7	1	4.2	5	20.8	0	0.0	0.231
	İnoperative	26	46.4	15	26.8	5	8.9	6	10.7	4	7.1	
	Other	16	61.5	6	23.1	1	3.8	0	0.0	3	11.5	
	Student	50	50.0	29	29.0	11	11.0	10	10.0	0	0.0	
	Public Employee	21	55.3	6	15.8	8	21.1	2	5.3	1	2.6	
	Private Sector	61	56.5	25	23.1	8	7.4	11	10.2	3	2.8	24.460 [b]
S3	Retired	15	62.5	4	16.7	2	8.3	3	12.5	0	0.0	0.223
	Public Employee	23	41.1	19	33.9	6	10.7	6	10.7	2	3.6	
	Other	17	65.4	5	19.2	1	3.8	1	3.8	2	7.7	
	Student	11	11.0	15	15.0	28	28.0	27	27.0	19	19.0	
	Public Employee	5	13.2	6	15.8	10	26.3	9	23.7	8	21.1	
	Private Sector	21	19.4	14	13.0	25	23.1	30	27.8	18	16.7	**47.188** [a]
S4	Retired	4	16.7	13	54.2	3	12.5	2	8.3	2	8.3	**0.001***
	Inoperative	5	8.9	17	30.4	10	17.9	20	35.7	4	7.1	
	Other	8	30.8	7	26.9	1	3.8	8	30.8	2	7.7	
	Student	4	4.0	16	16.0	46	46.0	24	24.0	10	10.0	
	Public Employee	2	5.3	9	23.7	13	34.2	12	31.6	2	5.3	
	Private Sector	12	11.1	12	11.1	37	34.3	36	33.3	11	10.2	**33.129** [b]
S5	Retired	3	12.5	6	25.0	2	8.3	10	41.7	3	12.5	**0.033***
	Inoperative	6	10.7	14	25.0	14	25.0	18	32.1	4	7.1	
	Other	0	0.0	6	23.1	10	38.5	6	23.1	4	15.4	
	Student	4	4.0	16	16.0	46	46.0	24	24.0	10	10.0	**32.767** [b]
S6	Public Employee	2	5.3	9	23.7	13	34.2	12	31.6	2	5.3	**0.036***
	Private Sector	12	11.1	12	11.1	37	34.3	36	33.3	11	10.2	
	Retired	3	12.5	6	25.0	2	8.3	10	41.7	3	12.5	
	Inoperative	6	10.7	14	25.0	14	25.0	18	32.1	4	7.1	
	Other	0	0.0	6	23.1	10	38.5	6	23.1	4	15.4	
	Student	2	2.0	40	40.0	24	24.0	18	18.0	16	16.0	
	Public Employee	1	2.6	19	50.0	3	7.9	9	23.7	6	15.8	
	Private Sector	5	4.6	32	29.6	33	30.6	24	22.2	14	13.0	27.688 [b]
S7	Retired	0	0.0	8	33.3	6	25.0	8	33.3	2	8.3	0.117
	Inoperative	3	5.4	12	21.4	11	19.6	17	30.4	13	23.2	
	Other	2	7.7	8	30.8	8	30.8	6	23.1	2	7.7	
	Student	6	6.0	18	18.0	25	25.0	28	28.0	23	23.0	
	Public Employee	2	5.3	10	26.3	5	13.2	14	36.8	7	18.4	
	Private Sector	17	15.7	13	12.0	27	25.0	29	26.9	22	20.4	**33.562** [b]
S8	Retired	5	20.8	8	33.3	2	8.3	7	29.2	2	8.3	**0.029***
	Inoperative	7	12.5	14	25.0	9	16.1	16	28.6	10	17.9	
	Other	7	26.9	6	23.1	1	3.8	7	26.9	5	19.2	
	Student	20	20.0	24	24.0	30	30.0	15	15.0	11	11.0	
	Public Employee	11	28.9	6	15.8	6	15.8	9	23.7	6	15.8	
	Private Sector	13	12.0	28	25.9	17	15.7	23	21.3	27	25.0	**34.096** [b]
S9	Retired	6	25.0	7	29.2	3	12.5	5	20.8	3	12.5	**0.025***
	Inoperative	6	10.7	16	28.6	6	10.7	19	33.9	9	16.1	
	Other	5	19.2	3	11.5	4	15.4	8	30.8	6	23.1	
	Student	0	0.0	2	2.0	7	7.0	34	34.0	57	57.0	
	Public Employee	0	0.0	0	0.0	1	2.6	10	26.3	27	71.1	
	Private Sector	2	1.9	3	2.8	5	4.6	35	32.4	63	58.3	28.827 [b]
S10	Retired	0	0.0	0	0.0	0	0.0	7	29.2	17	70.8	0.091
	Inoperative	0	0.0	0	0.0	3	5.4	10	17.9	43	76.8	
	Other	2	7.7	0	0.0	0	0.0	6	23.1	18	69.2	
	Student	0	0.0	1	1.0	9	9.0	43	43.0	47	47.0	
	Public Employee	0	0.0	0	0.0	3	7.9	10	26.3	25	65.8	
	Private Sector	0	0.0	4	3.7	11	10.2	35	32.4	58	53.7	24.352 [b]
S11	Retired	0	0.0	0	0.0	0	0.0	7	29.2	17	70.8	0.059
	Inoperative	0	0.0	0	0.0	1	1.8	16	28.6	39	69.6	
	Other	0	0.0	0	0.0	1	3.8	9	34.6	16	61.5	
	Student	2	2.0	16	16.0	16	16.0	32	32.0	34	34.0	**40.428** [b]
S12	Public Employee	0	0.0	0	0.0	3	7.9	12	31.6	23	60.5	**0.004***

	Private Sector	2	1.9	5	4.6	10	9.3	33	30.6	58	53.7	
	Retired	0	0.0	0	0.0	1	4.2	9	37.5	14	58.3	
	Inoperative	0	0.0	1	1.8	7	12.5	17	30.4	31	55.4	
	Other	2	7.7	2	7.7	2	7.7	8	30.8	12	46.2	
	Student	1	1.0	1	1.0	13	13.0	32	32.0	53	53.0	
	Public Employee	0	0.0	3	7.9	0	0.0	4	10.5	31	81.6	
S13	Private Sector	0	0.0	5	4.6	5	4.6	23	21.3	75	69.4	**43.688** [b] **0.002***
	Retired	0	0.0	0	0.0	0	0.0	11	45.8	13	54.2	
	Inoperative	0	0.0	1	1.8	5	8.9	16	28.6	34	60.7	
	Other	0	0.0	2	7.7	0	0.0	10	38.5	14	53.8	
	Student	27	27.0	45	45.0	18	18.0	9	9.0	1	1.0	
	Public Employee	16	42.1	14	36.8	5	13.2	2	5.3	1	2.6	
S14	Private Sector	39	36.1	42	38.9	17	15.7	8	7.4	2	1.9	20.932 [b] 0.401
	Retired	5	20.8	16	66.7	2	8.3	1	4.2	0	0.0	
	Inoperative	21	37.5	23	41.1	5	8.9	7	12.5	0	0.0	
	Other	8	30.8	13	50.0	4	15.4	0	0.0	1	3.8	
	Student	9	9.0	12	12.0	38	38.0	21	21.0	20	20.0	
	Public Employee	7	18.4	12	31.6	2	5.3	8	21.1	9	23.7	
S15	Private Sector	11	10.2	14	13.0	29	26.9	28	25.9	26	24.1	**34.144** [a] **0.025***
	Retired	3	12.5	4	16.7	4	16.7	8	33.3	5	20.8	
	Inoperative	8	14.3	5	8.9	12	21.4	15	26.8	16	28.6	
	Other	7	26.9	3	11.5	4	15.4	6	23.1	6	23.1	
		4	4.0	7	7.0	22	22.0	30	30.0	37	37.0	
	Student	0	0.0	2	5.3	8	21.1	14	36.8	14	36.8	
	Public Employee	1	0.9	6	5.6	25	23.1	26	24.1	50	46.3	
S16	Private Sector	0	0.0	0	0.0	3	12.5	13	54.2	8	33.3	24.520 [b] 0.220
	Retired	0	0.0	3	5.4	13	23.2	13	23.2	27	48.2	
	Inoperative	0	0.0	0	0.0	7	26.9	10	38.5	9	34.6	
	Student	0	0.0	2	2.0	3	3.0	43	43.0	52	52.0	
	Public Employee	0	0.0	2	5.3	1	2.6	11	28.9	24	63.2	
S17	Private Sector	1	0.9	1	0.9	4	3.7	27	25.0	75	69.4	30.929 [b]
	Retired	0	0.0	0	0.0	0	0.0	8	33.3	16	66.7	0.056
	Inoperative	0	0.0	0	0.0	0	0.0	14	25.0	42	75.0	
	Other	2	7.7	0	0.0	0	0.0	7	26.9	17	65.4	
	Student	1	1.0	12	12.0	5	5.0	37	37.0	45	45.0	**39.669** [b] **0.005***
S18	Public Employee	0	0.0	0	0.0	1	2.6	14	36.8	23	60.5	
	Private Sector	0	0.0	6	5.6	10	9.3	24	22.2	68	63.0	
	Retired	0	0.0	0	0.0	0	0.0	10	41.7	14	58.3	
	Inoperative	2	3.6	2	3.6	2	3.6	13	23.2	37	66.1	
	Other	2	7.7	1	3.8	1	3.8	7	26.9	15	57.7	
	Student	0	0.0	2	2.0	15	15.0	36	36.0	47	47.0	
	Public Employee	0	0.0	0	0.0	1	2.6	10	26.3	27	71.1	
S19	Private Sector	0	0.0	4	3.7	10	9.3	30	27.8	64	59.3	**34.075** [b] **0.026***
	Retired	0	0.0	2	8.3	0	0.0	6	25.0	16	66.7	
	Inoperative	0	0.0	1	1.8	4	7.1	14	25.0	37	66.1	
	Other	2	7.7	0	0.0	1	3.8	7	26.9	16	61.5	
	Student	0	0.0	3	3.0	8	8.0	38	38.0	51	51.0	
	Public Employee	1	2.6	0	0.0	3	7.9	10	26.3	24	63.2	
S20	Private Sector	0	0.0	2	1.9	4	3.7	22	20.4	80	74.1	**36.610** [b] **0.013***
	Retired	0	0.0	0	0.0	0	0.0	8	33.3	16	66.7	
	Inoperative	2	3.6	1	1.8	0	0.0	16	28.6	37	66.1	
	Other	2	7.7	0	0.0	1	3.8	6	23.1	17	65.4	
	Student	0	0.0	5	5.0	15	15.0	44	44.0	36	36.0	
	Public Employee	0	0.0	0	0.0	3	7.9	13	34.2	22	57.9	
S21	Private Sector	0	0.0	3	2.8	15	13.9	25	23.1	65	60.2	**41.716** [b] **0.003***
	Retired	0	0.0	1	4.2	0	0.0	8	33.3	15	62.5	
	Inoperative	0	0.0	1	1.8	4	7.1	22	39.3	29	51.8	
	Other	2	7.7	0	0.0	1	3.8	7	26.9	16	61.5	
	Student	0	0.0	3	3.0	9	9.0	31	31.0	57	57.0	
	Public Employee	0	0.0	0	0.0	0	0.0	12	31.6	26	68.4	
S22	Private Sector	0	0.0	2	1.9	14	13.0	27	25.0	65	60.2	**40.520** [b] **0.004***
	Retired	0	0.0	1	4.2	0	0.0	10	41.7	13	54.2	
	Inoperative	0	0.0	0	0.0	2	3.6	25	44.6	29	51.8	
	Other	2	7.7	0	0.0	0	0.0	8	30.8	16	61.5	

***: p<0.05; [a]:Ki-kare test ; [b]:Olabilirlik oranı**

Table 8. Participants' attitudes towards consuming tarhana according to their income level (N=352)

		Totally Disagree		Disagree		Undecided		Agree		Totally Agree		χ2 p
		N	%	n	%	n	%	n	%	n	%	
S1	0-1000	5	5.1	5	5.1	15	15.3	41	41.8	32	32.7	**33.362** [b] **0.007***
	1001-2000	0	0.0	2	6.9	5	17.2	11	37.9	11	37.9	
	2001-3000	2	2.9	4	5.9	8	11.8	26	38.2	28	41.2	
	3001-5000	0	0.0	1	1.3	5	6.6	29	38.2	41	53.9	
	5000 and above	5	6.2	2	2.5	4	4.9	21	25.9	49	60.5	
S2	0-1000	39	39.8	27	27.6	7	7.1	17	17.3	8	8.2	**39.211** [b] **0.001***
	1001-2000	16	55.2	3	10.3	0	0.0	7	24.1	3	10.3	
	2001-3000	39	57.4	18	26.5	2	2.9	7	10.3	2	2.9	
	3001-5000	52	68.4	11	14.5	3	3.9	9	11.8	1	1.3	
	5000 and above	48	59.3	16	19.8	8	9.9	3	3.7	6	7.4	
S3	0-1000	40	40.8	30	30.6	15	15.3	11	11.2	2	2.0	**28.215** [b] **0.030***
	1001-2000	15	51.7	10	34.5	2	6.9	1	3.4	1	3.4	
	2001-3000	38	55.9	12	17.6	5	7.4	12	17.6	1	1.5	
	3001-5000	49	64.5	15	19.7	4	5.3	7	9.2	1	1.3	
	5000 and above	45	55.6	21	25.9	10	12.3	2	2.5	3	3.7	
S4	0-1000	4	4.1	18	18.4	25	25.5	34	34.7	17	17.3	**37.578** [a] **0.002***
	1001-2000	4	13.8	12	41.4	8	27.6	3	10.3	2	6.9	
	2001-3000	13	19.1	16	23.5	10	14.7	22	32.4	7	10.3	
	3001-5000	17	22.4	8	10.5	21	27.6	18	23.7	12	15.8	
	5000 and above	16	19.8	18	22.2	13	16.0	19	23.5	15	18.5	
S5	0-1000	5	5.1	22	22.4	37	37.8	24	24.5	10	10.2	**34.960** [a] **0.004***
	1001-2000	2	6.9	3	10.3	13	44.8	11	37.9	0	0.0	
	2001-3000	4	5.9	9	13.2	24	35.3	24	35.3	7	10.3	
	3001-5000	12	15.8	9	11.8	14	18.4	30	39.5	11	14.5	
	5000 and above	4	4.9	20	24.7	34	42.0	17	21.0	6	7.4	
S6	0-1000	3	3.1	3	3.1	3	3.1	44	44.9	45	45.9	21.192 [b] 0.171
	1001-2000	0	0.0	0	0.0	0	0.0	13	44.8	16	55.2	
	2001-3000	0	0.0	2	2.9	4	5.9	30	44.1	32	47.1	
	3001-5000	2	2.6	3	3.9	2	2.6	20	26.3	49	64.5	
	5000 and above	2	2.5	4	4.9	2	2.5	24	29.6	49	60.5	
S7	0-1000	2	2.0	39	39.8	19	19.4	21	21.4	17	17.3	17.706 [b] 0.341
	1001-2000	2	6.9	4	13.8	10	34.5	6	20.7	7	24.1	
	2001-3000	1	1.5	24	35.3	14	20.6	20	29.4	9	13.2	
	3001-5000	4	5.3	28	36.8	19	25.0	14	18.4	11	14.5	
	5000 and above	4	4.9	24	29.6	23	28.4	21	25.9	9	11.1	
S8	0-1000	8	8.2	17	17.3	18	18.4	33	33.7	22	22.4	22.896 [a] 0.117
	1001-2000	2	6.9	7	24.1	11	37.9	6	20.7	3	10.3	
	2001-3000	11	16.2	10	14.7	15	22.1	20	29.4	12	17.6	
	3001-5000	14	18.4	11	14.5	12	15.8	24	31.6	15	19.7	
	5000 and above	9	11.1	24	29.6	13	16.0	18	22.2	17	21.0	
S9	0-1000	17	17.3	29	29.6	25	25.5	15	15.3	12	12.2	**31.701** [a] **0.011***
	1001-2000	2	6.9	7	24.1	9	31.0	8	27.6	3	10.3	
	2001-3000	6	8.8	13	19.1	11	16.2	23	33.8	15	22.1	
	3001-5000	15	19.7	17	22.4	12	15.8	13	17.1	19	25.0	
	5000 and above	21	25.9	18	22.2	9	11.1	20	24.7	13	16.0	
S10	0-1000	0	0.0	0	0.0	7	7.1	33	33.7	58	59.2	**36.768** [b] **0.002***
	1001-2000	0	0.0	0	0.0	2	6.9	12	41.4	15	51.7	
	2001-3000	2	2.9	0	0.0	1	1.5	26	38.2	39	57.4	
	3001-5000	2	2.6	3	3.9	1	1.3	11	14.5	59	77.6	
	5000 and above	0	0.0	2	2.5	5	6.2	20	24.7	54	66.7	
S11	0-1000	0	0.0	0	0.0	7	7.1	43	43.9	48	49.0	**30.257** [b] **0.003***
	1001-2000	0	0.0	0	0.0	1	3.4	11	37.9	17	58.6	
	2001-3000	0	0.0	0	0.0	5	7.4	31	45.6	32	47.1	
	3001-5000	0	0.0	3	3.9	3	3.9	15	19.7	55	72.4	
	5000 and above	0	0.0	2	2.5	9	11.1	20	24.7	50	61.7	
S12	0-1000	2	2.0	10	10.2	13	13.3	33	33.7	40	40.8	24.277 [b] 0.084
	1001-2000	0	0.0	2	6.9	3	10.3	9	31.0	15	51.7	
	2001-3000	0	0.0	3	4.4	8	11.8	30	44.1	27	39.7	
	3001-5000	4	5.3	3	3.9	7	9.2	18	23.7	44	57.9	
	5000 and above	0	0.0	6	7.4	8	9.9	21	25.9	46	56.8	
S13	0-1000	1	1.0	1	1.0	10	10.2	31	31.6	55	56.1	**43.075** [b] **0.000***
	1001-2000	0	0.0	0	0.0	4	13.8	11	37.9	14	48.3	
	2001-3000	0	0.0	0	0.0	4	5.9	21	30.9	43	63.2	
	3001-5000	0	0.0	9	11.8	0	0.0	13	17.1	54	71.1	
	5000 and above	0	0.0	2	2.5	5	6.2	20	24.7	54	66.7	
S14	0-1000	30	30.6	41	41.8	14	14.3	13	13.3	0	0.0	**32.246** [b] **0.009***
	1001-2000	6	20.7	18	62.1	5	17.2	0	0.0	0	0.0	
	2001-3000	20	29.4	36	52.9	10	14.7	2	2.9	0	0.0	
	3001-5000	32	42.1	30	39.5	6	7.9	5	6.6	3	3.9	
	5000 and above	28	34.6	28	34.6	16	19.8	7	8.6	2	2.5	
S15	0-1000	8	8.2	10	10.2	31	31.6	25	25.5	24	24.5	18.259 [b] 0.309
	1001-2000	2	6.9	4	13.8	9	31.0	7	24.1	7	24.1	
	2001-3000	6	8.8	12	17.6	20	29.4	16	23.5	14	20.6	
	3001-5000	12	15.8	11	14.5	11	14.5	21	27.6	21	27.6	
	5000 and above	17	21.0	13	16.0	18	22.2	17	21.0	16	19.8	
S16		2	2.0	7	7.1	23	23.5	31	31.6	35	35.7	

	0-1000											
	1001-2000	0	*0.0*	0	*0.0*	7	*24.1*	8	*27.6*	14	*48.3*	17.259 [b]
	2001-3000	0	*0.0*	3	*4.4*	17	*25.0*	23	*33.8*	25	*36.8*	
	3001-5000	0	*0.0*	6	*7.9*	16	*21.1*	22	*28.9*	32	*42.1*	0.369
	5000 and above	3	*3.7*	2	*2.5*	15	*18.5*	22	*27.2*	39	*48.1*	
		0	*0.0*	2	*2.0*	0	*0.0*	40	*40.8*	56	*57.1*	
	0-1000											
	1001-2000	0	*0.0*	0	*0.0*	2	*6.9*	11	*37.9*	16	*55.2*	**39.933** [b]
S17	2001-3000	0	*0.0*	0	*0.0*	2	*2.9*	29	*42.6*	37	*54.4*	
	3001-5000	2	*2.6*	3	*3.9*	1	*1.3*	12	*15.8*	58	*76.3*	**0.001***
	5000 and above	1	*1.2*	0	*0.0*	3	*3.7*	18	*22.2*	59	*72.8*	
		2	*2.0*	9	*9.2*	4	*4.1*	36	*36.7*	47	*48.0*	
	0-1000											
	1001-2000	0	*0.0*	3	*10.3*	2	*6.9*	9	*31.0*	15	*51.7*	24.265 [b]
S18	2001-3000	0	*0.0*	2	*2.9*	5	*7.4*	23	*33.8*	38	*55.9*	
	3001-5000	3	*3.9*	4	*5.3*	6	*7.9*	14	*18.4*	49	*64.5*	0.084
	5000 and above	0	*0.0*	3	*3.7*	2	*2.5*	23	*28.4*	53	*65.4*	
	0-1000	0	*0.0*	1	*1.0*	15	*15.3*	30	*30.6*	52	*53.1*	
	1001-2000	0	*0.0*	0	*0.0*	4	*13.8*	8	*27.6*	17	*58.6*	**42.733** [b]
S19	2001-3000	0	*0.0*	2	*2.9*	5	*7.4*	30	*44.1*	31	*45.6*	
	3001-5000	2	*2.6*	3	*3.9*	4	*5.3*	8	*10.5*	59	*77.6*	**0.000***
	5000 and above	0	*0.0*	3	*3.7*	3	*3.7*	27	*33.3*	48	*59.3*	
	0-1000	0	*0.0*	1	*1.0*	4	*4.1*	40	*40.8*	53	*54.1*	
	1001-2000	0	*0.0*	0	*0.0*	2	*6.9*	8	*27.6*	19	*65.5*	**42.290** [b]
S20	2001-3000	0	*0.0*	0	*0.0*	3	*4.4*	26	*38.2*	39	*57.4*	
	3001-5000	3	*3.9*	2	*2.6*	4	*5.3*	6	*7.9*	61	*80.3*	**0.000***
	5000 and above	2	*2.5*	3	*3.7*	3	*3.7*	20	*24.7*	53	*65.4*	
	0-1000	0	*0.0*	4	*4.1*	14	*14.3*	37	*37.8*	43	*43.9*	
	1001-2000	0	*0.0*	0	*0.0*	4	*13.8*	7	*24.1*	18	*62.1*	16.581 [b]
S21	2001-3000	0	*0.0*	2	*2.9*	6	*8.8*	26	*38.2*	34	*50.0*	
	3001-5000	2	*2.6*	2	*2.6*	6	*7.9*	20	*26.3*	46	*60.5*	0.413
	5000 and above	0	*0.0*	2	*2.5*	8	*9.9*	29	*35.8*	42	*51.9*	
		0	*0.0*	1	*1.0*	7	*7.1*	31	*31.6*	59	*60.2*	
	0-1000											
	1001-2000	0	*0.0*	0	*0.0*	2	*6.9*	11	*37.9*	16	*55.2*	19.262 [b]
S22	2001-3000	0	*0.0*	0	*0.0*	3	*4.4*	27	*39.7*	38	*55.9*	
	3001-5000	2	*2.6*	1	*1.3*	5	*6.6*	18	*23.7*	50	*65.8*	0.255
	5000 and above	0	*0.0*	4	*4.9*	8	*9.9*	26	*32.1*	43	*53.1*	

***: p<0.05; [a]:Ki-kare test ; [b]:Olabilirlik oranı**