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The Effect of Marination with Kiwi Fruit Juice, Ginger Juice, and Transglutaminase on the Some Technological and Textural Properties of Spent Chicken Meat

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Abstract

Marination practices provide positive contributions to the nutritional value of meat, its shelf life, the elimination of bad taste and odor caused by oxidation products, and the development of antioxidant, antimicrobial, and textural properties. It is also stated that the formation levels of substances such as heterocyclic aromatic amines and polycyclic aromatic hydrocarbons, which have some carcinogenic properties that may pose a risk to human health, are reduced to the lowest levels in meat and meat products that are marinated before heat treatment. The most commonly used ingredients for marinating applications in meat technology include spices, medicinal and aromatic plants, some organic acids, fruit and vegetable juices, milk and dairy products, and vegetable oils. This study determined the effect of treatment with different marinating liquids on the textural, sensory, and technological properties of fresh chicken meat, which has completed its economic yield period. For this purpose, chicken breast meat was used and marinated in 4 different liquids. Fresh kiwi juice (K group), fresh ginger juice (G group), a transglutaminase enzyme solution (T group), and water (W-control group) were used as marinating liquid. Textural and some technological properties of chicken breast meat were determined before and after 24 hours of marination. The marination process reduces the degree of hardness and chewiness in the textural properties of meat. Among the samples, in group T, it was determined that the %cooking loss and %drip loss rates of meat were the lowest and the %yield values were the highest. Treatment of chicken hen's meat with transglutaminase enzyme gave more effective and positive results on crispness and textural properties; marination with fresh kiwi juice and fresh ginger juice positively improved the technological properties of the samples were concluded.

Keywords: Chicken; ginger, kiwi; marination; transglutaminase;

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1. Introduction

It is evident that adhering to the technological and hygienic protocols that are mandatory from the manufacturing stage of meat and meat products until their availability for consumption is inadequate for ensuring food preservation. The history of marinated meats such as seafood dates back to the 7th century, when its production became widespread in all European countries, particularly in Germany, due to the large-scale fishing of herring, especially in the 19th century (1). The marination process, which has been employed since the 1600s and continues to the present, is predicated on the principle of "preserving meat and fish by keeping them in brine for a certain period." The application of marination processing is extensive in contemporary times, encompassing a wide range of purposes. These include the production of dense solutions with high-fat content and fluid solutions with high water content, both without the application of heat treatment. Additional applications include the crisping (softening) of light or dark-colored meat pieces, the development of the unique taste and smell of the product, and the enhancement of product yield. The process is defined as "the technology that enables the meat to mature and extend its shelf life by treating it with various mixtures." The mixture employed in the marination process is referred to as a "marinate" (2).

The marinating process has been shown to enhance several quality attributes of meat, including its water retention capacity, moisture content, protein solubility, crispness, and product yield. It has also been demonstrated to mitigate cooking losses and deformations, while concurrently improving the color formation and sensory characteristics of the meat, such as its taste and smell. A wide array of marinating agents, encompassing salt, phosphates, organic acids, fruit juices, and crispening and sweetening agents, can be utilized in meat technology. In the acidic marination process, the utilization of acidic solutions, such as vinegar, wine, and fruit juices, is prevalent (3, 4, 5, 6, 7). The marination process is predominantly executed through the immersion of meat in these solutions. It has been documented that the application of acidic marinades enhances the crispness of meat by promoting proteolysis and collagen-gelatin conversion during the cooking process, thereby weakening its structural integrity. Additionally, acidic marinades have been observed to possess antimicrobial properties, which can improve the textural and sensory characteristics of meat while concurrently reducing its pH level (8, 9).

In this study, fresh kiwi juice, fresh ginger juice, water, and transglutaminase enzyme solutions were used to evaluate some quality parameters of chicken hen’s meat that have completed the economic yield period, before and after marination, as well as the effects of cooking and drying processes applied to the meat on the textural, sensory, and some technological properties of the samples, the effect was determined.

2. Materials and Method

Material: The chicken hen’s meat was obtained from Aytaç A.Ş., and after the carcasses, which were slaughtered under appropriate slaughtering conditions and completed the rigor mortis process, were deboned, the breast meat parts were separated and analyzed under aseptic and cold conditions, delivered to laboratories of the Karamanoğlu Mehmetbey University Faculty of Engineering, Department of Food Engineering. Fresh kiwi and fresh ginger were obtained from affordable greengrocers in Karaman province, and marinating liquids were obtained with the help of a juicer. Transglutaminase (Tgase) enzyme had an activity of 120 U/g and was produced by Elit Food Inc. (Istanbul).

Method: The chicken hen’s breast meat was marinated in 4 different liquids. Fresh kiwi juice (K group), fresh ginger juice (G group), 1% transglutaminase enzyme solution (T group) and water (W-control group) were used as marinades. Textural and some technological properties (%marinate absorption, %cooking loss, %drip loss, and %yield) of the chicken hen’s breast meats were analysed before the marination process and after the 24-hours (+4°C) marination, cooking, and drying processes.

After marination, the marinades were removed from the samples. The samples were baked at a temperature of 95°C until an in ternal temperature of 72°C was reached. Than, the samples were dryed at 12°C for 72 hours by controlled airflow and sliced 1.5 mm thickness (Griffin Machinery, China).

Technological Analysis Methods: Cooking loss (CL), marinade absorption (MA), drip loss (DL) and yield analyzes were performed by (10). The weight change during the marinating and cooking processes was measured and calculated by substituting it in the relevant formula. The weight of each group of samples was recorded before marinating (w1), after 12 hours of marinating (w2), after 24 hours of storage with marinades (w3) and after cooking (w4) and the following calculations were made;

%Marinate absorbtion = [(w2-w1) / (w1)] x 100

%Drip loss = [(w2-w3) / (w2)] x 100

%Cooking loss = [(w2-w4) / (w2)] x 100

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%Yield = (w4/w1) x 100

Texture Profile Analysis: Texture profile analysis (TPA) was performed on sample groups before and after the marination process, after the cooking and drying processes, with the TAXT2i Texture Analyzer (Texture Technologies Corp., Scarsdale, NY/Stable Micro Systems, Godalming, Survey, UK) device. The samples were compressed twice with 50% compression. A cylindrical 36 mm diameter probe was used as the probe, and the analysis was carried out by applying a trigger force of 0.06N, with a pre-test speed of 5mm/s and 2mm/s test speed, and a time between two compressions of 10s. During the measurement, six repetitions were made and the textural parameters; hardness (N), springiness, cohesiveness, gumminess, chewiness, and resilience values were determined (11).

Statistical Analysis: The obtained data were subjected to Variance Analysis using the MINITAB release 16.0 program and the Tukey Multiple Comparison Test was applied to check whether the differences between the group averages were significant (12).

3. Results and Discussion

Technological Properties: The effect of the marinade type, the applied process factors and the "marinate type x process" interaction on the technological properties of chicken hen's meat was found to be statistically significant (P<0.01). The effects of marination liquids on cooking loss, drip loss, marinate absorption, and yield values of meat samples are indicated in Figure 1.

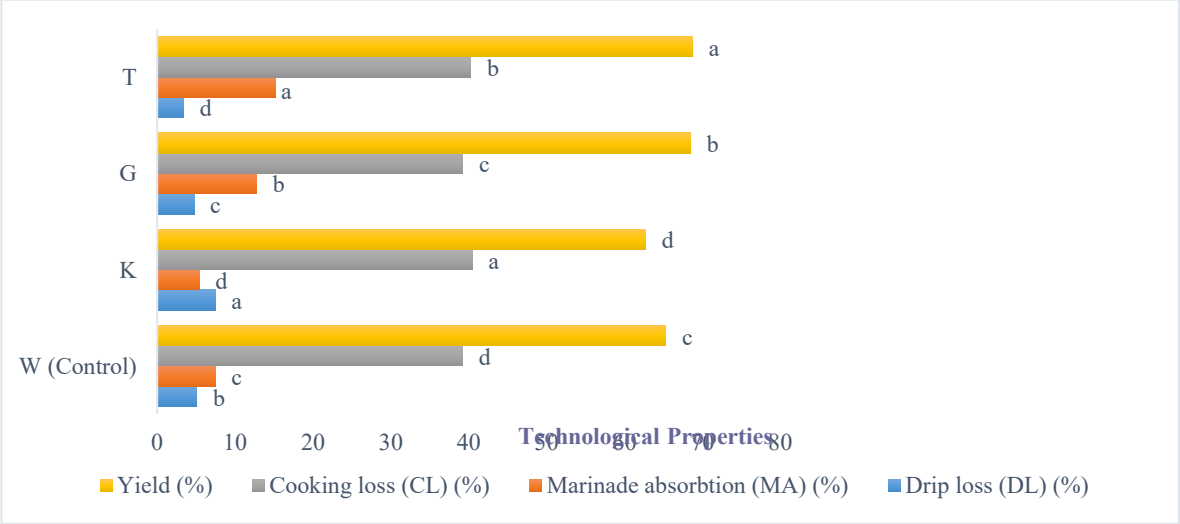

Figure 1. Effect of different marinades and processes on the technological properties of chicken hen's meat. W: chicken meat marinated in water/control group; K: chicken meat marinated with fresh kiwi juice; G: chicken meat marinated with fresh ginger juice; T: chicken meat marinated with transglutaminase enzyme solution.

Cooking loss values of chicken breast meat marinated with different marinades were found to be significantly higher than the control group. While drop loss of the K group increased compared to the control group, and decreased in the G and T groups. The use of ginger and Tgase significantly increased the marinate absorption and yield of the meat (Figure 1). Due to the increase in temperature during the cooking process, myofibrillar proteins, especially the complex part of actomyosin, are denatured, causing the muscle fiber to shrink. This situation causes water loss from the product as it reduces the water retention ability of myofibrils (13, 14). In addition, it is suggested that treating meat with proteolytic enzymes causes structural changes, causing denaturation of myofibrillar proteins in the muscle, and thus increases the cooking loss of meat (15). For this reason, when enzymatic processes are applied to meat and meat products, the water retention capacity decreases significantly (16).

Textural Characteristics: The effect of the marinade type, applied process and the "marinate type x process" interaction on the hardness, chewiness, springiness, cohesiveness, gumminess, and resilience results of chicken breast meat was found to be statistically significant (P<0.01) (Table 1).

Table 1. TPA results of the samples*

Sources of variation	n	Hardness	Springiness	Cohesiveness	Gumminess	Chewiness	Resilience
Marinade type (A)		*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*
Water (Control-W)	12	$113,35^{b}$	$0,93^{a}$	$0,77^{a}$	$91,98^{b}$	$82,38^{a}$	$0,61^{b}$
Fresh Kiwi juice (K)	12	$67,11^{d}$	$0,96^{a}$	$0,76^{ab}$	$50,57^{d}$	$47,81^{c}$	$0,65^{a}$
Fresh Ginger juice (G)	12	$122,62^{a}$	$0,86^{c}$	$0,75^{b}$	$96,70^{a}$	$86,12^{a}$	$0,54^{c}$
Tgase (T)	12	$93,86^{c}$	$0,89^{b}$	$0,77^{a}$	$72,67^{c}$	$67,00^{b}$	$0,56^{c}$
Process (B)		*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*
Fresh meat (Control-F)	12	$104,49^{b}$	$0,91^{b}$	$0,72^{c}$	$73,80^{c}$	$66,39^{c}$	$0,49^{b}$
Marination (M)	12	$36,01^{d}$	$0,80^{c}$	$0,64^{d}$	$21,68^{d}$	$17,77^{d}$	$0,48^{b}$
Cooking (C)	12	$157,23^{a}$	$0,89^{b}$	$0,80^{b}$	$127,44^{a}$	$113,83^{a}$	$0,36^{c}$
Drying (D)	12	$99,22^{c}$	$1,04^{a}$	$0,89^{a}$	$89,00^{b}$	$85,31^{b}$	$1,02^{a}$
A x B		*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*	*p<0,01*
W x F	3	$104,49^{f}$	$0,91^{def}$	$0,72^{fg}$	$73,80^{e}$	$66,39^{d}$	$0,49^{d}$
W x M	3	$34,99^{i}$	$0,53^{f}$	$0,61^{i}$	$19,40^{h}$	$13,46^{f}$	$0,41^{ef}$
W x C	3	$189,91^{b}$	$0,90^{def}$	$0,85^{cd}$	$161,77^{b}$	$145,74^{a}$	$0,42^{def}$
W x D	3	$124,00^{e}$	$1,07^{ab}$	$0,91^{a}$	$112,96^{d}$	$103,91^{c}$	$1,10^{a}$
K x F	3	$104,49^{f}$	$0,91^{def}$	$0,72^{fg}$	$73,80^{e}$	$66,39^{d}$	$0,49^{d}$
K x M	3	$33,58^{i}$	$0,93^{cde}$	$0,73^{f}$	$23,45^{h}$	$21,78^{f}$	$0,64^{c}$
K x C	3	$59,49^{h}$	$0,85^{f}$	$0,70^{g}$	$41,56^{g}$	$35,26^{e}$	$0,30^{g}$
K x D	3	$70,90^{g}$	$1,14^{a}$	$0,90^{a}$	$63,47^{f}$	$67,79^{d}$	$1,15^{a}$
G x F	3	$104,49^{f}$	$0,91^{def}$	$0,72^{fg}$	$73,80^{e}$	$66,39^{d}$	$0,49^{d}$
G x M	3	$34,82^{i}$	$0,71^{g}$	$0,57^{j}$	$18,75^{h}$	$15,83^{f}$	$0,38^{f}$
G x C	3	$217,03^{a}$	$0,85^{ef}$	$0,81^{e}$	$172,75^{a}$	$147,64^{a}$	$0,37^{fg}$
G x D	3	$134,15^{d}$	$0,95^{cd}$	$0,89^{ab}$	$121,50^{d}$	$114,60^{bc}$	$0,92^{b}$
T x F	3	$104,49^{f}$	$0,91^{def}$	$0,72^{fg}$	$73,80^{e}$	$66,39^{d}$	$0,49^{d}$
T x M	3	$40,64^{i}$	$0,73^{g}$	$0,65^{h}$	$25,13^{h}$	$20,00^{f}$	$0,49^{de}$
T x C	3	$162,48^{c}$	$0,94^{cd}$	$0,83^{de}$	$133,69^{c}$	$126,69^{b}$	$0,35^{fg}$
T x D	3	$67,84^{g}$	$1,00^{bc}$	$0,87^{bc}$	$58,07^{f}$	$54,94^{d}$	$0,92^{b}$

*Means marked with different letters in the same column are statistically (P<0.01) different from each other.

According to the TPA parameters results, the marination process reduces the hardness of the meat, and especially kiwi juice is very effective on meat hardness. This decrease in hardness value is thought to result from the activity of proteolytic enzymes on myofibrillar proteins and the breakdown of connective tissue. Myosin is the most basic and abundant protein in muscle, and any change in the myosin molecule also affects the texture and water retention capacity of the meat (17). It has been determined that the processes applied to meat, especially cooking, increase the hardness value (Table 1). Since the hardness of meat tissue is inversely proportional to the moisture content of meat, water loss in meat during cooking and drying processes may be effective in the development of this condition (13).

The chewiness value depends on the hardness and elasticity values (17), therefore, in our study, the decrease in the elasticity and chewiness values of the meat due to the activity of some proteolytic enzymes as a result of marinating the meat with kiwi juice, ginger juice and transglutaminase enzyme solution has a direct effect on the chewiness value; It was determined that cooking and drying processes caused an increase in chewiness values.

In our study, the effect of the type of marinade used in the marinating process applied to chicken hen's breast meat on the springiness and resilience values from the textural properties of the meat was found to be statistically significant ($P<0.01$) (Table 1). The marinating chicken meat with fresh ginger juice caused a decrease in the springiness and resilience of the meat while marinating it with fresh kiwi juice caused an increase in this values. The low pH of the K group is thought to increase the elasticity of the product as a result of denaturing proteins and connective tissue and increasing the water holding capacity of the meat. In dried meat products, resilience is determined by the interaction of water and protein in the product. A higher moisture content is usually associated with a higher resilience value, because moisture provides a lubricity between protein molecules and increases elasticity. However, over-drying can cause the proteins to harden and reduce resilience. High resilience values can make the product have a pleasant texture during chewing, while low resilience can make the product harder and difficult to chew. This situation was explaned in the some studies (18, 19).

In the present study, the impact of the marinade type on the cohesiveness of chicken hen's breast meat during the marinating process was found to be statistically significant ($P <0.01$) (Table 1). The findings of this study indicate that marinating fresh chicken meat in water leads to an increase in the cohesiveness value of the meat. This situation is thought to be caused by the crushing, softening and dissolving effect of fresh kiwi juice, fresh ginger juice and Tgase used for marinating on meat proteins and connective tissue. As a matter of fact, it was reported that similar findings were obtained in some studies (17, 18, 19).

In our study, the effect of the type of marinade used in the marination of fresh chicken hen's breast meat on the gumminess was found to be statistically significant ($P<0.01$) (Table 1). Marinating with fresh ginger juice increases gumminess of the meat; and determined that marination with fresh kiwi juice reduced this value. Texture and tenderness are presently most important of all the attributes of meat eating quality by consumers (20). And marinating was more important in loosening the muscle structures, destroying the connections between myofibrils and collagen, thus increasing the tenderness and gummines (21, 22). Particularly, marination with fresh ginger juice was more effective in destroying the connection between the myofibers and connective tissue (23).

4. Conclusion

It has been demonstrated that marinating with fresh kiwi juice (K), fresh ginger juice (G), and Tgase (T) can enhance the textural and quality properties of spent hen's meat. The cooking loss, drip loss, marinate absorption, and yield values of meat marinated with K, G, and Tgase were found to be significantly affected by these treatments. More comprehensive and sustainable studies are needed for human nutrition of chicken hen's meat, which has completed its economic yield period. As a matter of fact, as a result of our study, it was seen that fresh Kiwi juice (K), fresh ginger juice (G) and Tgase (T) can be used at appropriate levels in the marination process applied to chicken meat to improve the textural and technological properties.

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Conflicts of Interest: The authors declare no conflict of interest.

Ethics: This study does not require ethics committee approval.

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