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Research Article

Determinatiom of Germinated Wheat Flour Addition on the Sensory and Texture Properties of White Bread and Whole Wheat Bread

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Abstract

The aim of this study is to compare and identify addition of germinated wheat flour on the sensory and texture properties of white bread and whole wheat bread. Germinated wheat flour was mixed with white flour and whole-wheat flour at the ratio of 50% (w/w). Sensory analysis was conducted on the bread samples to evaluate their appearance, texture, taste, aroma, and overall satisfaction. Results showed that bread prepared with germinated wheat flour mix was more fragile, rough and moisty internal structure. However in terms of taste, no significant differences among the samples ($p>0.05$) were found. The aroma analysis revealed a noticeable grain and wheat scent. Overall, bread made from germinated wheat flour provided more palate satisfaction compared to the other types of bread. Texture analysis also yielded similar results, indicating that bread prepared with germinated wheat flour was thicker, less elastic, and less sticky than the others. According to the statistical analysis, germinated wheat flour bread was generally considered as successful, and can bu used for bread preparation by mixing with wheat flour.

Keywords: Germination, Germinated Wheat, Functional Antioxidant Food, Wheat Germ, Bread, Wheat

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Introduction

In societies, grains and grain products are considered fundamental sources of nutrition. Bread, in particular, is seen as the most crucial grain product. However, in the world we live in today, bread is no longer perceived as the sole staple food source. It has evolved into diverse products that cater to changing consumer preferences, securing its place in the market. This diversification has prompted the need to redefine the product mix. Today, bread has transcended its fundamental utility and ascended to a level where it is not only a staple but also a genuine and differentiated product [13].

Germination is an economical and simple method to enhance nutrient quality. Nutrient levels in sprouts have been shown to be higher compared to non-germinated seeds, and several studies have demonstrated elevated levels of anti-nutrients in sprouts [47]

Edible grain and seed sprouts, when used as a food source, provide the human body with numerous antioxidants. These types of foods are considered particularly rich in antioxidant compounds. The main antioxidants found in such foods include:

- Chlorophyll
- Vitamins A, E, and C
- Phenolic compounds
- Zinc
- Selenium

Additionally, broccoli, radish, Brussels sprouts, mustard, and cabbage sprouts contain a variety of glucosinolates and isothiocyanates [24].

Seed germination/sprouting has been practiced since ancient times. However, its importance has increased in recent times, particularly in the context of healthy nutrition. Sprouts contain numerous components that are essential for human health, contributing to the prevention of various diseases [36]. Edible germinated grains are obtained through the process of soaking seeds in water for a specific period, followed by washing and draining, and then allowing them to germinate under suitable humidity and temperature conditions. The germinating process brings about significant changes in the nutritional components of edible seeds. These changes are influenced by environmental conditions such as temperature, duration, lighting, as well as the type of seed and cultural diversity [24].

Today, some consumers incorporate the shoots of seeds germinated from legumes, grains, brassicas, and root vegetables into their diet by consuming them as salads. Additionally, germinated seeds and the functional foods derived from them are beginning to find their place in the food industry. Various germinated grains are used in a range of food products in the food industry, including breakfast items, salads, soups, pasta, and baked goods [27].

The increasing awareness of conscious consumption has elevated the value of germinated grains and vegetables in food consumption. Particularly in recent years, germinated food products have become highly popular in the gastronomy sector. The habit of germinating is spreading globally, not only among those who engage in sports and prioritize their nutrition but also among a broader audience [19].

Materials and Methods

Material Production

Germinated wheat flour and other wheat flours were obtained from the Kappadokia brand in Kırşehir. Yeast and salt were sourced from local markets.

White Flour: Kappadokia, Kırşehir/Turkey
Whole Wheat Flour: Kappadokia, Kırşehir/Turkey
Germinated Wheat Flour: Kappadokia, Kırşehir/Turkey
Dry Yeast: Dr. Oetker, Turkey
Water: Şahinbey/Gaziantep Tap Water, Gaziantep/Turkey
Instant Yeast: Dr. Oetker, Turkey
Salt: Billur, Turkey

For each type of flour, the same brand of salt and yeast has been used. The amount of water was determined based on the water absorption capacity of the flour.

Sensory Analysis

The initial phase of the sensory analysis of the bread used in this study was conducted at the Gaziantep Gastronomy Academy, involving gastronomy undergraduate and graduate students, as well as chefs from Bulla, the academy's practice restaurant. The panelists participating in the sensory analysis comprised 48 individuals, ranging in age from 20 to 53 (28 males, 20 females). As the bread samples were intended for general consumer preference, panelists did not receive specific sensory analysis training.

Additionally, a sensory analysis was carried out at the İzmir/Torbalı Public Education Center (Torbalı HEM). In this sensory analysis, 23 untrained panelists (15 males, 8 females) were involved. The overall sensory analysis, conducted with a total of 71 untrained panelists [29], has been completed through this process.

The produced bread samples, sized uniformly (4 cm^2 surface area, 6 cm height) and including both crust parts (bottom crust and top crust), were coded differently (e.g., 07, 04, 93, etc.). They were presented to untrained panelists, consisting of both men and women, along with drinking water, a saliva cup, green apple, and plain crackers. Panelists were instructed to conduct a comprehensive sensory analysis for each bread sample, answering questions related to color, taste, appearance, texture, overall liking, and likelihood of repurchase on the sensory analysis form provided to them [22, 29, 32]

For the evaluation of the samples in the sensory analysis, a 7-point hedonic scale was utilized, and panelists were asked to rate each bread sample on a scale from one to seven [22, 23]. To provide a more detailed view of the obtained sensory analysis results, a radar chart method was preferred. Random sample selection was employed in the sample selection process. The universe in the consumer test conducted within the scope of sensory analysis consisted of Gaziantep Gastronomy Academy employees, Bulla Applied Restaurant chefs, Torbalı Public Education Center (HEM) employees, and participants in basic culinary training programs.

Texture Analysis

Texture analysis was conducted using the Texture Analysis Machine (TA.XT PlusC, Stable Micro Systems, UK) at the Central Laboratory of Çukurova University (ÇÜMERLAB). Bread samples, each cut to a size of 36mm on every side, were tested with a 25mm aluminum cylindrical probe. Each sample was compressed up to 50%. Texture Profile Analysis (TPA) was performed with a force resolution of 0.1g and a speed range of 0.01-40mm/s. Five types of bread samples (white bread (WHE), whole wheat bread (WWHE), bread made from germinated wheat flour (GWHE), bread made from a mixture of white flour and germinated wheat flour (MGWHE), and bread made from a mixture of whole wheat flour and germinated wheat flour (MWWHE)) were produced in triplicate, totaling 15 bread samples. Four samples were taken from each bread, cut to a diameter of 36mm, and flattened at the top for better results. This test measured the hardness, adhesiveness, springiness,

gumminess, chewiness, and resilience degrees of the bread.

The bread subjected to this test was baked on the same day as the test and cooled for at least 2 hours. After cooling, the packaging process was carried out, and the samples were processed 3 hours after packaging.

Statistical Analysis

The sensory analysis of five bread samples (WHE, WWHE, GWHE, MGWHE, MWWHE) was conducted with 71 untrained panelists. They were asked to evaluate and score the appearance features, texture characteristics, taste attributes, aroma qualities, and overall satisfaction. Descriptive statistics, including mean scores, standard deviations (SD), variances, and medians, were calculated. For multiple comparisons, the data were subjected to statistical analysis using Analysis of Variance (ANOVA) with IBM SPSS software (version 26.0; SPSS Inc., Chicago, IL, USA). Sensory analysis results were analyzed using Friedman tests, and LSD ranking tests were employed to determine if there were any significant differences between the samples ($p < 0.05$).

Volume and Mass Determination

The masses of the prepared bread doughs were measured with precision scales before baking. All bread samples were baked at the same temperature (190°C). Approximately 60 minutes after baking (once cooled), each bread sample underwent a second measurement. The difference in mass between the dough stage and after baking was recorded. The percentage mass loss was determined according to the formula in equation(2.1). Mass loss results are shown in *figure 2.*

$$\text{Mass Loss } (\%)=(A1-A2/A1)\times 100 \quad (2.1)$$

Where:

$A1$: Weight of raw dough (g)

$A2$: Weight of the baked bread after cooling (g)

Volume determination based on the displacement principle with flaxseed was carried out in accordance with the AACC 10-05 method [1]. The flaxseed method involves adding a known volume of flaxseed to a food sample. After the sample is filled with flaxseeds, the volume filled by the seeds is measured. This measurement determines the volume of the sample filled with seeds. The specific volume value for the bread samples was determined by relating the volume value to the weight value. The volume was determined according to the formula in equation (2.2). Volume loss results are shown in *figure 3*.

$$\text{Volume}=(A\times C/A\times B)*\text{H}=FV/HFC \quad (2.2)$$

Where:

A: Cap Width

B: Cap Height

C: Cap Volume

H: Height Difference

FV: Flaxseed Volume

HFC: Height of Flaxseed in the Cap

Study Results and Discussion

In this study, wheat that had been germinated, dried, and ground into flour was used, in contrast to its more commonly used form of ungerminated wheat. For ease of comparison, bread was produced using white flour (WHE) and whole wheat flour (WWHE). Additionally, bread was made

by combining germinated wheat flour with other flours (white flour and whole wheat flour) in a mixture (50% each). These five bread samples (WHE, WWHE, GWHE, MGWHE, MWWHE) underwent both sensory and texture analyses.

According to the sensory analysis, the bread made from germinated wheat flour (GWHE), the main subject of the study, was found to be firmer compared to the other types of bread used in the study. The bread made from germinated wheat flour (GWHE) exhibited fragility in texture characteristics, which correlated with its firmness. In the breads produced in a mixture (MGWHE and MWWHE), it was observed that the addition of germinated wheat flour resulted in an increase in fragility and firmness levels *(Table 3).*

In terms of aroma characteristics, the bread made from germinated wheat flour had a distinct aroma and taste, with a pronounced intensity of grain and wheat aromas. Looking at the overall satisfaction results, GWHE lagged behind WHE in terms of general liking, but it showed similar results to the other bread types (WWHE, GWHE, MGWHE) used in the study*(Figure 5).*

Texture analysis results confirmed that, in line with sensory analysis findings, GWHE exhibited a higher level of firmness compared to the others. The spreadability level of GWHE was lower, consistent with the fragility level observed in sensory analysis*(Table 2, Table 3).*

In conclusion, despite having an unusual taste and texture, GWHE received positive feedback in all conducted analyses. It was determined that germinated wheat flour can be successfully used in breadmaking, either alone or in a mixture.

According to the analysis and observations:

1. **General Liking:** The bread made from germinated wheat flour (GWHE), while not a conventional bread type, was well-received*(Figure 5).*
2. **Purchase Intention:** Consumers were able to discern the difference in bread made from germinated wheat flour (GWHE)*(Figure 5).*
3. **Consumability Decision and Intent to Re-Try:** White bread (WHE) was more liked compared to bread made from germianted wheat flour (GWHE)*(Figure 5).*
4. **Flavor Perception:** Bread made with a mixture of germinated wheat flour (MGWHE and MWWHE) was closely associated with whole wheat bread (WWHE)*(Figure 5).*
5. **General Satisfaction:** Bread made from germinated wheat flour (GWHE) was compared to rye bread in terms of color and texture*(Figure 5).*
6. **Texture Analysis:** While white bread (WHE) distinctly differed in texture, other bread samples (WWHE, GWHE, MGWHE, MWWHE) showed similar results *(Table 2).*

Additionally, it is noted that all bread samples, regardless of the inclusion of germinated wheat flour (GWHE), underwent the same stages and tests in the simple bread-making logic. The bread made from germinated wheat flour (GWHE) did not progress to the product development stage due to this reason. In future studies, it is believed that if bread made from germinated wheat flour (GWHE) is prepared using different techniques and yeast types, the results could be significantly different. Factors such as fermentation time, degree of

fermentation, and type of yeast strongly influence the bread's form. Therefore, selecting the right bread-making stages and ingredients according to germinated wheat flour becomes crucial for facilitating the general population's preference for white bread in the next stage.

Conclusion

In studies by Ünsal et al. (2020) [43], observations were made in sensory analysis results of flatbreads made with germinated flour. An increase in the proportion of germinated wheat flour led to a decrease in symmetry and shape, affecting all sensory characteristics significantly. In particular, a noticeable decrease in pore structure was observed in flatbreads, dependent on the amount of germinated wheat flour used.

Kömürcü (2021)[26], compared bread samples with the addition of germinated esperia wheat flour with a control sample. It was determined that as the amount of germinated flour increased, the liking ratio decreased. Evaluation of this bread in terms of taste, aroma, and general liking suggested that using less germinated wheat flour would result in a bread closer to general liking. In this study, GWHE received less preference compared to the familiar WHE. Despite its unfamiliar taste and texture, GWHE's liking situation remained average in sensory analyses*(Figure 5)*. Therefore, GWHE represents a healthy bread alternative.

In conclusion, the bread made from germinated wheat flour has been identified as an alternative bread type based on sensory analysis and texture analysis results. It was well-received in sensory analysis, showing aromatic qualities, and was repeatedly desired to be tried by the panelists. Structurally, it exhibited similarities to commonly consumed bread types today (white bread, whole wheat bread) and was found to be consumable. The mixed bread types produced in the study for diversification purposes (MGWHE and MWWHE) also received positive feedback in sensory analysis. White bread made from common wheat flour (WHE) was generally preferred as a familiar taste. Other bread types, excluding WHE, showed similar results in terms of preference. Whole wheat bread (WWHE), a well-known variety, showed similar results to bread made with germinated wheat flour. These bread varieties were found to be functional alternatives for daily use, indicating ease of use and potential for regular consumption*(Table 2, Table 3)*.

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Table 1. Standard Bread Recipes

Standard White Bread Recipe	250 g white flour, 163 ml water, 2 g instant yeast, 3 g salt
Standard Whole Wheat Bread Recipe	250 g whole wheat flour, 167 ml water, 2 g instant yeast, 3 g salt
Standard Germinated Wheat Bread Recipe	250 g germinated wheat flour, 168 ml water, 2 g instant yeast, 3 g salt
Standard Germinated Wheat and White flour, 165 Bread Recipe	125 g germinated wheat flour, 125 g white ml water, 2 g instant yeast, 3 g salt
Standard Germinated Wheat and Whole wheat Wheat Bread Recipe	125 g germinated wheat flour, 125 g whole flour, 167 ml water, 2 g instant yeast, 3 g salt

Fig1 Flow Chart for Bread Preparation

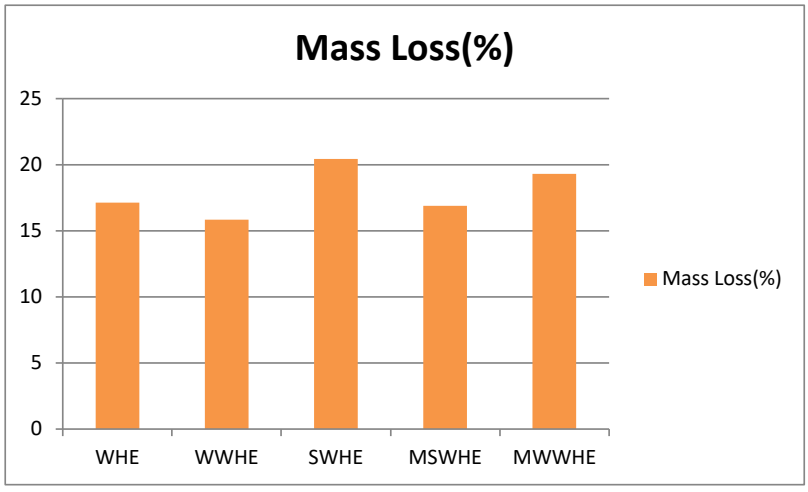


Fig 2 Specific Mass Graphic

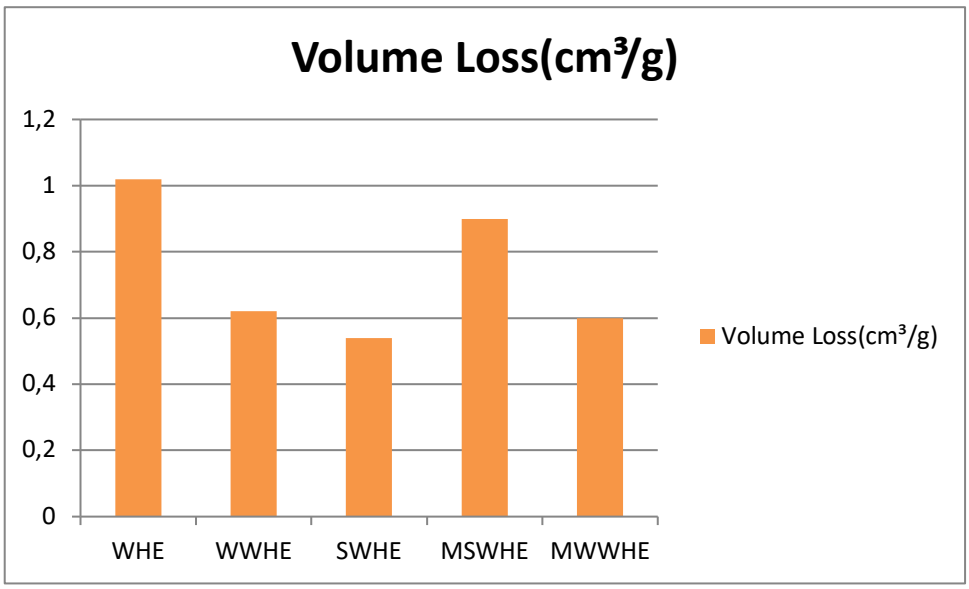


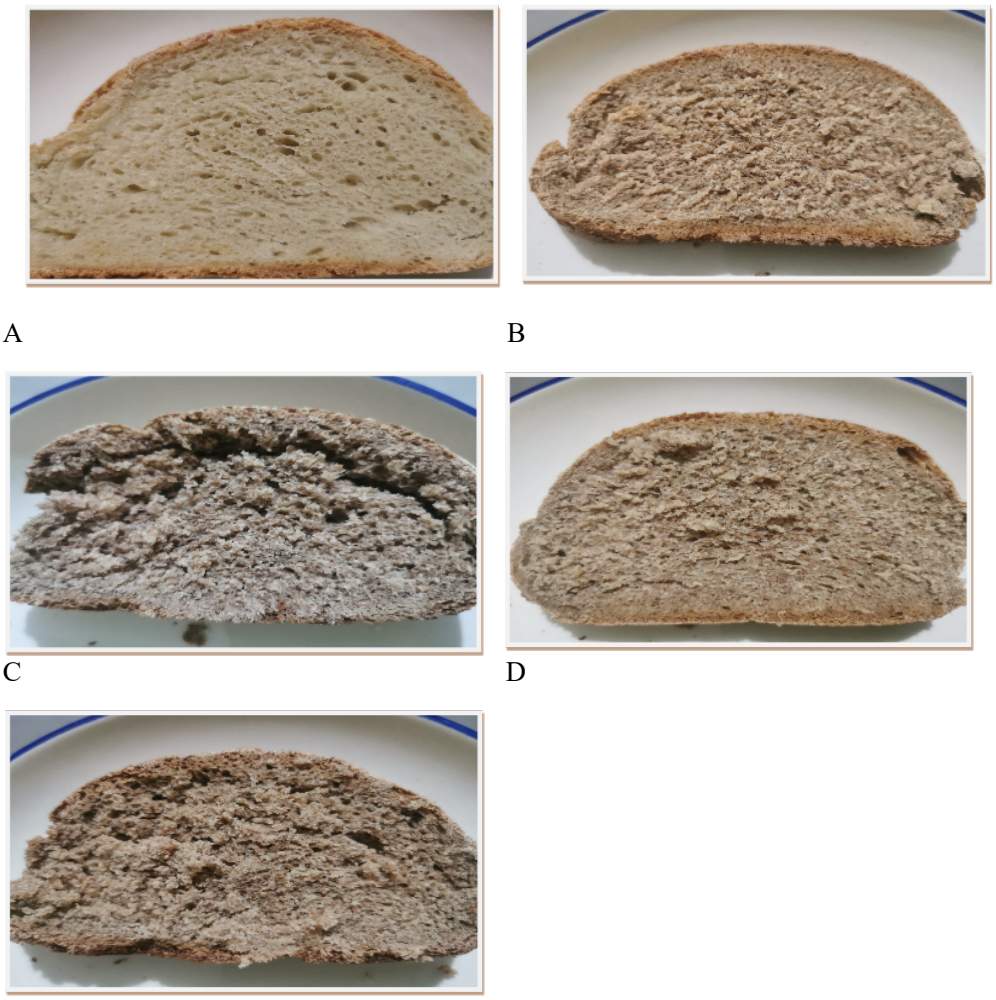
Fig 3 Specific Volume Graphic

Table 2 Texture Analysis of Bread Samples

Types of flour used	Firmness (g)	Springiness (mm)	Gumminess (g)	Chewiness (Nmm)	Durability (N)	Stickiness (mm)
WHE	517,6 ± 40,52^{e}	0,25 ± 0,01^{a}	376,50 ± 28,97^{e}	382,52 ± 35,39^{d}	23,49 ± 0,001^{a}	0,18 ± 0,001^{a}
WWHE	663,29 ± 36,36^{d}	0,18 ± 0,004^{b}	384,85 ± 19,35^{d}	292,23 ± 18,51^{e}	0,05 ± 0,0007^{cd}	0,14 ± 0,0008^{cd}
GWHE	1768,86 ± 140,01^{a}	0,18 ± 0,18^{d}	989,66 ± 111,99^{b}	744,74 ± 88,20^{b}	0,05 ± 0,001^{c}	0,13 ± 0,005^{d}
MGWHE	1621,47 ± 330,72^{b}	0,18 ± 0,005^{b}	1061,03 ± 56,41^{a}	803,21 ± 42,73^{a}	0,05 ± 0,0008^{c}	0,15 ± 0,001^{bc}
MWWHE	1019,24 ± 26,51^{c}	0,21 ± 0,004^{c}	682,46 ± 18,42^{c}	600,20 ± 23,49^{c}	0,07 ± 0,0005^{b}	0,16 ± 0,0005^{ab}

Table 3 Consumer Test Sensory Analysis Data of Bread Varieties

Types of Flour Used	Appearance Features	Texture Features	Flavor Attributes	Flavor Profile	Overall Satisfaction
WHE	5,43 ± 0,21^{d}	3,08 ± 0,27^{e}	2,90 ± 0,26^{e}	2,51 ± 0,09^{e}	5,72 ± 0,35^{a}
WWHE	5,13 ± 0,44^{e}	3,75 ± 0,20^{c}	3,36 ± 0,51^{b}	4,35 ± 0,27^{d}	4,75 ± 0,31^{b}
GWHE	6,71 ± 0,35^{a}	4,16 ± 0,18^{a}	3,35 ± 0,12^{c}	4,69 ± 0,26^{a}	3,90 ± 0,32^{d}
MGWHE	5,76 ± 0,31^{b}	4,00 ± 0,21^{b}	3,23 ± 0,03^{d}	4,46 ± 0,18^{c}	3,10 ± 0,10^{e}
MWWHE	5,58 ± 0,11^{c}	3,58 ± 0,26^{d}	3,55 ± 0,21^{a}	4,50 ± 0,19^{b}	3,90 ± 0,30^{c}



A B C D E

Fig4 White Bread Pore Appearance (A), Whole Wheat Bread Pore Appearance (B), Germinated Wheat Bread Pore Appearance (C), MGWHE Pore Appearance (D), MWWHE Pore Appearance (E)

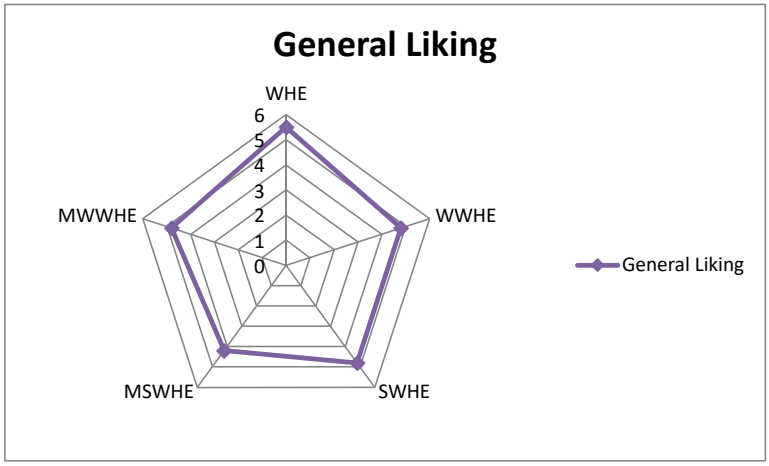


Fig5 General Liking Graphic