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Investigation of the effect of bug-damaged wheat and ascorbic acid on the physicochemical and sensory characteristics of Zabol traditional cookie

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ABSTRACT

Bug-damage wheat is one of the agricultural wastes, which by entering the human cycle will significantly contribute to the industry of baking products. Therefore, in the present study, bug-damage wheat flour at levels of 10, 20 and 30% was replaced by healthy wheat flour in the formulation of traditional Zaboli cookies and ascorbic acid at levels of 30 and 60 pp was used to compensate. The results showed that the amount of moisture, ash, fat, protein, Falling's number and Zeleny's number of healthy and bug-damage wheat flour could not be a suitable indicator to detect healthy and bug-damage wheat. This was despite the fact that the amount of wet gluten and gluten index were effective parameters for distinguishing between healthy and healthy and bug-damage wheat, and the amount of gluten and gluten index was higher in the flour sample obtained from healthy wheat. Also, the results showed that by replacing healthy and bug-damage wheat flour, the moisture level of cookies decreased. Ascorbic acid was successful in maintaining the moisture of the cookies during the baking process and after. In addition, based on the results, it was indicated that the sample containing 10% bug-damage wheat flour and 30 ppm of ascorbic acid had the highest specific volume and the lowest firmness during one month of storage. The presence of bug-damage wheat flour and ascorbic acid in the formulation led to the darker and lighter color of the samples, respectively. Based on the overall acceptance score, it was determined that the sample containing 10% bug-damage wheat flour and 30 ppm ascorbic acid (first priority), the control sample (without bug-damage wheat flour and ascorbic acid) (second priority) and the sample containing 20 The percentage of bug-damage wheat flour and 60 ppm of ascorbic acid (third priority) were the three best samples. But since the purpose of using bug-damage wheat flour, the samples containing bug-damage wheat flour (first and third priority) are introduced as the best samples in terms of technological and sensory properties.

1-Introduction

Every city has special souvenirs and they are considered representative and reminder of that city [1]. Kuleche is a type of sweets whose main ingredients are wheat flour, oil, sugar and eggs. According to the type and formulation of this product, other materials such as flavors and colors and nutritious compounds are used in its preparation [2]. Many traditional cookies in Iran, including Sistan, Gorgan, Foman, Dezful and Khuzestan cookies are considered souvenirs. There are generally three types of cookies in Sistan: plain or oil cookies, date cookies, and sugar cookies. The noteworthy point is that the wheat flour used in the production of cookies is weaker compared to bread flour and its protein content is lower [3]. henceIt is possible to use the flour of other cereals and pseudo-cereals (barley, rye, oat, triticale, millet, sorghum, rice, corn, quinoa, buckwheat, amaranth, etc.) [4 and 5] and aged wheat flour, which has a low amount of gluten and is considered a weak flour, in appropriate levels mixed with wheat flour to produce cookies [6]. The oldest and most important pest that attacks wheat is the sen insect (*Eurygaster integriceps*) is The damage caused by age salivary protease on the qualitative characteristics and bakery value of wheat is far more than the quantitative damage caused by it. The destructive effect of this enzyme is caused by the breakdown of gluten [7]. Siviri et al. (2002) reached the conclusion that sen protease weakens the dough obtained from sen wheat either through the disintegration of glutenin polymers or by affecting the aggregation of gluten molecules [8]. With the breakdown of gluten as a result of wheat age protease enzyme, a weak gluten network is created in the dough of bakery products, which is not able to keep the gas resulting from the fermentation process, and the produced product will have a low height, volume and porosity, and its texture and structure cannot be compared with the sample obtained from healthy wheat flour [9]. kneeling and Azar (2017) reported a decrease in baking quality, including an increase in weight loss, a decrease in porosity and volume as a result of the use of aged flour in bread formulation. In general, making bread with damaged and aged wheat flour faces many technological and sensory problems. The dough obtained from this type of wheat has a fast resting time and subsequently the volume of the produced product is low and its texture is weak[10]. Destructive enzyme activity in aged flours by weakening the gluten network leads to the production of a weak and sticky dough with low mobility and malleability. Due to the weakness in water retention, this dough has a low consistency and tolerance coefficient, and its internal texture is of poor quality and its sensory properties such as texture, chewability, shape and form, color, smell and taste are undesirable [11]. This has caused food industry researchers to suggest this type of flour for making cookies and biscuits that need weak flour. Of course, the use of additives and improvers in the baking industry in the production of this category of products has been considered to achieve the desired result and a marketable product. Ascorbic acid, which is one of the oxidizing agents, is one of the additives used to strengthen weak wheat flour and partially compensate for the damage caused by aging [12]. The mechanism of action of ascorbic acid as an improver is that first, ascorbic acid is converted to dehydroascorbic acid in the presence of oxygen. At the same time as this glutathione reaction (GSH), which is a natural tripeptide in flour, is converted to glutathione disulfide by the enzyme glutathione dehydrogenase.GSSG) becomes In fact, dehydroascorbic acid is the oxidation of thiol groups (-SH) catalyzes and creates crosslinks in the protein structure and strengthens the gluten network of the dough [13 and 14]. Fragile et al. (2007) reported that the most important effect of ascorbic acid is to oxidize the sulfhydryl groups in the dough, as a result of which the gluten network is strengthened [15]. By improving this network, the elasticity of the dough obtained from aged wheat flour increases, the hardness of the texture of the resulting bakery product decreases and the volume increases [11]. Kiyashko and Slideltsey (2022) reported with the use of ascorbic acid as an improver with oxidizing function on the rheological and technological and sensory characteristics of bread. The surface of the crust of the samples containing ascorbic acid was more uniform and flat and without cracks, bulges and depressions compared to the control bread. The color of these samples was brighter and glassy and without burns. The kneading and baking process was improved. The stickiness of the dough decreased. Bread containing ascorbic acid had a better aroma and taste [16]. Studies show that the amount of ascorbic acid needed for weak flours, including aged wheat, is about 50-75 ppm, and if more than the required amount is used, not only the positive physicochemical and technological effects are not observed, but the dough is too sticky, which leads to its lack of spreadability. Also, the texture of the final product will be hard and uneven [17]. Therefore, taking into account that every year a large amount of wheat is removed from the human cycle due to the sen pest and is used for livestock and poultry feed, the purpose of this research was to use senescent wheat flour (at zero, 10, 20 and 30 percent levels) and ascorbic acid (at zero, 30 and 60 ppm levels) in the formulation of traditional Zabul cookies in order to use agricultural by-products and reduce waste in this field.

2- Materials and methods

2-1- Materials

Aged wheat (about 10% aging) was obtained from the General Department of Grain and Commercial Services of Hamadan province, and wheat flour with an extraction degree of 75% was obtained from Reza Flour Factory (Qochan-Iran). After threshing and turning into flour, the aged wheat was passed through a 60 mesh sieve with a hammer mill. Then, two flour samples were stored in a cool warehouse in dry conditions until the tests were carried out. Ascorbic acid was purchased from Novin Delsa Food Industries Development Company (Mashhad-Iran), Shirin Kar brand sugar (Alborz-Iran), Sepid Dana brand salt (Shiraz-Iran) and solid oil were purchased from a confectionary store in Mashhad. Yeast used *Saccharomyces cerevisiae* (*Saccharomyces cerevisiae*), which was in the form of active dry yeast powder and vacuum packed, was obtained from Razavi Yeast Company (Mashhad, Iran) and chemicals were obtained from Merck Company (Germany). It should be noted that the moisture content of healthy and aged wheat flour is 12.12 and 11.70%, ash 0.49 and 0.47%, protein 11.50 and 10.00%, fat 0.94 and 0.89%, wet gluten 29.00 and 23.50%, gluten index 78.60 and 59.40, Zelani number. 28/00 and 13/00 and the falling number was 362/00 and 338/00 seconds.

2-2-Methods

2-2-1- Preparation of cookies

The preparation and baking of Zablei traditional cookie dough (plain type) (control sample) was done using raw materials including 100% whole wheat flour, 25% solid oil, 2% powdered sugar, 0.5% yeast, 0.3% salt and 20% water. To prepare the treatments, aged wheat flour was replaced with healthy wheat flour at 0, 10, 20 and 30% levels. Also, due to the presence of aged wheat flour among the ingredients, three levels of zero, 30 and 60 ppm ascorbic acid were used in the cookie formulation. To prepare cookie dough, sugar powder, yeast and warm water (temperature 35 degrees Celsius) were mixed together in a 250 cc beaker and kept in a steady state for 5 minutes (until a foamy state was observed and in other words, yeast action). Then flour, salt and oil until a uniform dough is reached in a laboratory mixer (model BJY-BM5N, manufactured by Beik Sanat Company, Iran) were mixed. Then the yeast was added to them and kneading was done manually for 5 minutes. Then the dough was covered with polyethylene wrappers and the dough went through its resting stage for 1 hour and 30 minutes at ambient temperature (25 degrees Celsius). Then, the prepared dough was rolled out on a wide silicone plate using a rolling pin and ready to be molded with a round cutter with a diameter of 2 and a height of 0.5 cm. At the end, cookie doughs were arranged on a tray and placed in a laboratory oven (model XFT135, made in Italy) with a temperature of 180 degrees for 25 minutes. After baking, the samples were kept in polyethylene bags at room temperature to perform the relevant tests.

2-2-2-moisture

To perform this test of the standard AACC (2000) No. 44-16 was used [18]. For this purpose, the samples are tested in a time interval of 2 hours (on the first day after the samples have completely cooled down), 2 weeks and one month after baking in the oven (mark Let's go Tech, model OF-O2G, made in South Korea) with a temperature of 100-105 degrees Celsius.

2-2-3-Special volume

For this purpose, the method of replacing the volume with rapeseed according to the standard AACC (2000) No. 10-72 was used [18]. In this way, the weight and volume of a number of cookies were determined, and the specific volume was calculated in milliliters per gram by dividing the volume by the weight of the sample.

2-2-4-texture

In order to measure the texture hardness of the cookie samples at a time interval of 2 hours, 2 weeks and one month after baking, using a texture measuring device (model TA more, made in England) was used. For this purpose, a cylindrical probe with a diameter of 5 mm was used. The speed before the test was 1 mm/s, the speed of the test was 0.5 mm/s, the depth of penetration was 2 mm, and the amount of loading was 50 kg, and finally the hardness of the cookies was reported in terms of Newton [19].

2-2-5-Color ($L^*a^*b^*$)

To measure the color components of the surface of the cookies in a time interval of 2 hours after baking, it was done as follows: a) Image processing system: for imaging, from a digital camera (Canon EOS 1000D, Taiwan) was used. In this method, the image of a wooden room with black walls, which has 4 fluorescent lamps (OpplE, modEl: MX396-Y82) was 8 watts and was 60 cm long and was installed on a camera stabilization stand. JPEG were saved. b) Image pre-processing: Intersection of images (separating the real image from the background) using Photoshop software.Adobe, v.8.0) was done and the photos were formatted bmp were saved. c) Changing the color space RGB to $L^*a^*b^*$: Because the color parameters $L^*a^*b^*$ It is not dependent on the measurement tool, it provides uniform color regardless of the output or input, the images obtained are in the color space. $L^*a^*b^*$ became In this study, image analysis using ImageJ software (Image J) edition 1.43r was done [20].

2-2-6-sensory features

For this purpose, 10 referees were selected. Sensory properties of cookies were evaluated in terms of form and shape, upper surface characteristics, lower surface characteristics, firmness and softness of texture, chewability and smell and taste. The attribute evaluation coefficient was based on five-point hedonic from very bad (1) to very good (5) [21 and 22]. The investigated properties are not equally effective in sensory evaluation. Therefore, after checking the sources, the ranking coefficient was given as 4, 2, 1, 2, 3 and 3 respectively. At the end, having this information, the overall score (cookie quality number) was calculated using equation 1.

$$(P*G)/\Sigma PS \quad Q= \qquad \text{Relationship 1}$$

that in this regard Q Overall acceptance (cookie quality number), P Attribute rank coefficient and G It is the evaluation coefficient of attributes.

3-2-7-Statistical analysis

For this purpose, a completely random design based on factorial two factors was used. For statistical analysis of software Mini-Tab17 And in order to compare the mean, Tukey's test was used with a confidence level of 95%.$P<0.05$).All the experiments were done with three repetitions except the sensory characteristics. For sensory characteristics, 30 repetitions were considered (number of repetitions in cooking (3) × number of evaluators(10)). Drawing diagrams using software Excel was.

3-Results and discussion

3-1-humidity

The results of the moisture content of the production samples are presented in Table 1. As the findings show, by replacing healthy wheat flour with aged wheat flour, the moisture content of the cookies significantly (P<0.05) was reduced. Also, the results indicated more moisture retention in the samples containing ascorbic acid during one month of storage.

Table 1: The effect of bug-damage wheat and acid ascorbic on the moisture of cookies during 1 month.

Treatments	Bug-damage wheat (%)	Acid ascorbic (ppm)	Moisture (%)		
			2 hours	2 weeks	1 month
1 (Control)	-	-	13.27±0.50^{cd}	11.20±0.30^{defg}	11.20±0.30^{fgh}
2	-	30	14.87±0.35^{ab}	13.60±0.56^{ab}	13.60±0.56^{ab}
3	-	60	15.60±0.36^{a}	14.13±0.32^{a}	14.13±0.32^{a}
4	10	-	12.80±0.36^{cd}	10.10±0.57^{fgh}	10.10±0.57^{fgh}
5	10	30	13.80±0.26^{bc}	12.37±0.56^{bcd}	12.37±0.56^{cde}
6	10	60	14.83±0.31^{ab}	13.43±0.47^{ab}	13.43±0.47^{abc}
7	20	-	12.47±0.55^{of}	9.77±0.38^{gh}	9.77±0.38^{gh}
8	20	30	12.77±0.60^{cde}	11.77±0.78^{cde}	11.77±0.78^{cde}
9	20	60	13.67±0.49^{bcd}	13.17±0.40^{abc}	13.17±0.40^{bcd}
10	30	-	11.70±0.44^{and}	8.87±0.35^{h}	8.87±0.35^{h}
11	30	30	12.83±0.25^{cde}	10.33±0.47^{efgh}	10.33±0.47^{efg}
12	30	60	13.40±0.46^{cd}	11.33±0.61^{def}	11.33±0.61^{def}

Different letters in each column represent significant difference from one another (p<0.05).

In general, based on the results, it was found that the sample without aged wheat flour and containing 60 ppm of ascorbic acid had the highest amount of moisture compared to other production samples (12 samples). The lowest moisture content during one month of storage was observed in the sample containing 30% aged wheat flour without ascorbic acid. In this regard Gentleman et al. (2005) and Hariri et al. (2000) reported that baking products made from aged wheat have a lower ability to maintain moisture during the baking process and after, due to the destruction of the gluten network and the reduction of the gluten index [23, 24]. The presence of aged wheat flour in the formulation of baking products was faced with a decrease in moisture content and water activity. Reducing moisture and water activity is important from a microbial point of view, because by reducing the amount of water activity and water available to microorganisms, the microbial activity in the product decreases and its shelf life increases. Also, the results showed that by adding ascorbic acid to the cookie formulation, the production samples had more moisture during one month of shelf life. This effect is due to the strengthening of the gluten network in doughs made from aged wheat by ascorbic acid, which is an oxidizing agent. The mechanism of action of ascorbic acid as an improver is that first, ascorbic acid is converted to dihydroascorbic acid by the presence of oxygen. Simultaneously with this reaction, glutathione (GSH), which is a natural tripeptide in flour, is converted to glutathione disulfide by the enzyme glutathione dehydrogenase.GSSG) becomes [9]. In fact, dehydroascorbic acid creates crosslinks in the protein structure [14]. According to the research conducted, the most important effect of ascorbic acid is to oxidize thiol groups (-SH(existing in gluten, from the substitution reactions of these groups with disulfide bonds)S-S) which is considered a destructive reaction for the dough, it prevents and improves the gluten network, and finally better preservation of moisture during the cooking process and a better shelf life [17]. Shokraie et al. (2018) to investigate the rheological and qualitative properties of pasta prepared from aged wheat flour and ascorbic acid they paid The results showed that the increase of aged wheat in the formulation had no effect on the moisture content of the production samples. This was while the presence of ascorbic acid led to an increase in humidity [9]. Sheikholeslamiet al. (2018) investigated the effect of a mixture of ascorbic acid and guar gum on the improvement of weakened wheat flour caused by mixing with uncoated barley flour. The results of this research indicated that the presence of 2% uncoated barley flour, 1% guar gum and 200 ppm ascorbic acid led to better moisture retention during storage [17]. Mirzaei (2012) studied the formulation and evaluation of the effect of several types of improvers (combination of ascorbic acid, xylanase enzyme and sodium stearoyl 2-lactylate emulsifier) on the quality of Sangak bread. In this research, the optimal improver formula contained 70 ppm of ascorbic acid, 36 mg of xylanase enzyme, and 0.6% sodium stearoyl 2-lactylate emulsifier, which led to an increase in the amount of water absorption and bread moisture compared to the sample without these additives [25].

2-3-Special volume

The results of the specific volume of production samples are presented in Figure 1. As the results show, the sample containing 10% aged wheat flour and 30 ppm of ascorbic acid had the highest specific volume compared to other manufactured cookies. It should be noted that the sample without aged wheat flour and 60 ppm of ascorbic acid and the sample containing 30% of aged wheat flour and without ascorbic acid had the lowest specific volume.

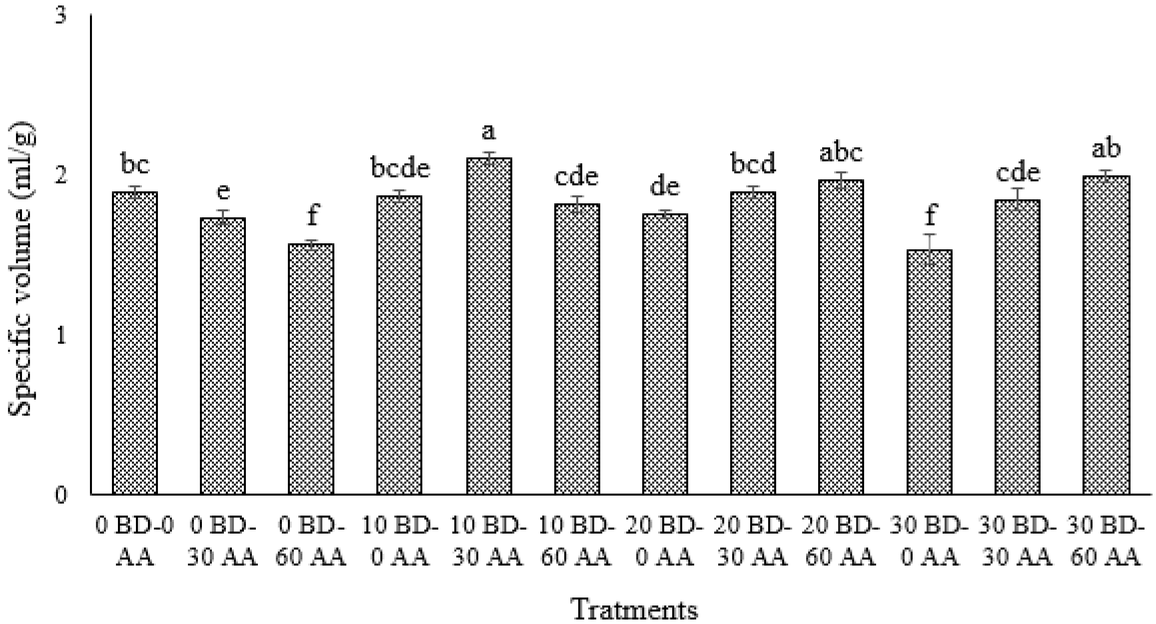

Fig 1: The effect of bug-damage wheat (BD) and acid ascorbic (AA) on the specific volume of cookies. Different letters represent significant difference from one another ($p<0.05$).

The volume of bakery products is an important factor that plays a significant role in the appearance and marketability and is an important feature in the evaluation of the final product. The volume of bakery products is affected by various factors such as the number of air bubbles entering the dough or exiting it (during the mechanical process of mixing the dough, air bubbles enter and during kneading, molding and kneading, part of the air bubbles are removed) or bubbles produced from biological activity (yeast activity) and chemical activity (such as baking powder and baking soda), their preservation and preservation in the dough and during cooking, as well as the proper evaporation of water, the presence of various types Additives depend and if there is a disorder in one case, the volume will decrease [26 and 27]. As the results of the interaction between aged wheat flour and ascorbic acid showed, at high levels of aged wheat flour (30% level), the specific volume reduction was significant compared to the control sample, and only at the highest level of ascorbic acid consumption, there was technological damage caused by replacing

30% of healthy wheat flour with aged wheat flour.It was able to compensate. Siviri et al. (2000) reported the cause of damage to the technological characteristics of baking products, including volume reduction, as a result of the use of aged wheat flour in the formulation of this category of products, saying that age protease either through the disintegration of glutenin polymers or by affecting the aggregation of gluten molecules, weakens the dough obtained from aged wheat [8]. With the breakdown of gluten as a result of wheat age protease enzyme, a weak gluten network is created in the dough of bakery products, which is not able to hold the gas resulting from the fermentation process, and the produced product will have a low height, volume and porosity, and its texture and structure cannot be compared with the sample obtained from healthy wheat flour [9]. Also Ozulku and Siviri Ozay (2020) reported the destructive effect of age protease on the baking properties of wheat and the occurrence of problems in the preparation of bakery products when gluten and grain starch are broken down by age digestive enzymes [7]. Due to the decomposition of gluten, it no longer has the power to retain the gases resulting from the process of fermentation and chemical and physical aeration. As a result, the baking products produced from aged wheat flour do not have good porosity and volume, and their crispness is lower than the samples prepared from whole wheat [28]. findings kneeling and Azar (2017) by studying the use of aged flour in bread formulation, showed that baking quality, including increased weight loss, reduced porosity and volume, decreased by replacing healthy wheat flour with aged and increasing the substitution level. There are also reports regarding the improvement of texture characteristics of bakery products as a result of adding ascorbic acid to the formulation [10]. Mafirombon et al. (2007) reported that the most important effect of ascorbic acid is to oxidize the sulfhydryl groups in the dough, as a result of which the gluten network is strengthened [15]. By improving this network, the elasticity of the dough obtained from aged wheat flour increases, the hardness of the texture of the resulting bakery product decreases and the volume increases [11]. Kiyashko and Slideltsey (2022) reported using ascorbic acid as an improver with oxidizing function on the rheological and technological and sensory characteristics of bread. The final effect of ascorbic acid is to increase the ability of the dough to retain gas, improve the expansion of the dough, increase the strength of the dough and finally increase the volume and produce a product with a fine and uniform cell structure [16]. On the other hand, ascorbic acid should be consumed in the necessary amount, and if it is used more than appropriate, it not only does not improve the taste, but also shows harmful effects, and causes the dough to harden, reduce the volume, and make the texture of the manufactured product undesirable [12]. Ghayor Moal et al. (2007) investigated the effect of alpha-amylase enzyme and ascorbic acid on the rheological properties of dough and the specific volume of strudel bread. The results showed that ascorbic acid had an effective role in increasing dough strength and dough elasticity and increasing the specific volume of bread, and the best effect was observed at 100 ppm [29].

3-3-Hardness of tissue

The results of the texture hardness of the produced samples are presented in Table 2. As the findings show, the sample containing 10% aged wheat flour and 30 ppm ascorbic acid and the sample containing 20% aged wheat flour and 60 ppm ascorbic acid jointly had the lowest tissue stiffness after one month of storage. It should be noted that all production samples had an increase in tissue stiffness during the storage period. Although the texture hardness of the sample containing 30% of aged wheat flour (without ascorbic acid) after one month of baking time was more than other production samples, but this increase of texture stiffness in the control sample (without aged wheat flour and ascorbic acid) was more than other treatments, which indicates that the rate of staleness of the control sample is higher compared to other production cookies.

Table 2: The effect of bug-damage wheat and acid ascorbic on the firmness of cookies during 1 month.

Treatments	Bug-damage wheat (%)	Acid ascorbic (ppm)	Firmness (N)		
			2 hours	2 weeks	1 month
1 (Control)	-	-	19.72±0.69[g]	9.24±0.68[bc]	19.72±0.69[ab]
2	-	30	14.88±0.58[fg]	8.03±0.85[cde]	14.88±0.58[fg]
3	-	60	15.38±0.54[efg]	6.94±0.51[efg]	15.38±0.54[efg]
4	10	-	17.00±0.82[cde]	8.38±0.48[cd]	17.00±0.82[cdg]
5	10	30	14.57±0.52[g]	6.61±0.25[fg]	14.57±0.52[g]
6	10	60	15.46±0.79[efg]	7.05±0.12[defg]	15.46±0.79[efg]
7	20	-	18.12±0.62[bc]	10.20±0.20[b]	18.12±0.62[bc]
8	20	30	16.21±0.47[defg]	6.96±0.26[efg]	16.21±0.47[defg]
9	20	60	14.65±0.25[g]	6.27±0.24[g]	14.65±0.25[g]
10	30	-	19.99±0.72[a]	13.75±0.76[a]	19.99±0.72[a]
11	30	30	17.92±0.28[cd]	8.71±0.29[c]	17.92±0.28[cd]
12	30	60	16.42±0.43[cdef]	7.94±0.27[cdef]	16.42±0.43[cdef]

Different letters in each column represent significant difference from one another ($p<0.05$).

Texture is one of the important quality indicators of food, which can change during food processing and storage for various reasons. Texture is a set of characteristics of food that can be felt with fingers, tongue or teeth. Evaluation of food texture involves measuring the response of food products when subjected to forces such as cutting, chewing, squeezing or stretching, and in other words depends on the rheological properties of the food. The teeth, tongue and jaw apply force to the food and what kind of reaction it shows against the forces is an expression of the texture of the food and determines whether the food is hard, crunchy, smooth, etc. [30]. The degree of firmness of the texture of baked products in the time period immediately after baking depends on factors such as maintaining the moisture of the product during the baking process (although the importance of moisture during the storage period is greater due to its effect on the intensity of the staleness of the product) and some of its technological characteristics such as volume and porosity. Maintaining moisture prevents the shell from hardening and even becoming brittle after the production process and even during cooking, and the texture of the product becomes softer. On the other hand, the increase in volume and porosity due to the presence of more air bubbles in the sample and their uniform distribution are two factors that affect the softness of the texture and decrease the compression of the inner texture of bakery products [31]. Therefore, it could be predicted that the samples with a larger volume have a lower texture stiffness in the time period immediately after baking. On the other hand, it was expected that the samples that had more moisture during the storage period would have a softer texture. Because due to the uniformity of formulation water for 12 treatments, the samples with higher moisture content in the time period immediately after cooking have a greater ability to maintain moisture during the storage period. These samples prevent the rapid migration of moisture from the inner tissue to the shell, and in other words, the exit of moisture and loss of water, which is the main cause of staleness and hardening of the texture of bakery products during storage, takes place very slowly. But this point should not be ignored that if the amount of ascorbic acid is more than the requirement of the formula, it not only does not act as an improver but also leads to the hardening of the tissue of the production samples [17]. It is noteworthy that the replacement of healthy wheat flour with aged wheat flour in small quantities not only did not lead to a decrease in the texture quality of the cookies and an increase in the stiffness of their internal structure, but also had a positive effect on the texture, as a result of which a softer texture was observed. Charity et al. (2014) reported the improvement of physical characteristics (thickness, diameter, improvement of expansion characteristics) by using protease enzyme in cookie formulation. These researchers stated that the protease enzyme by affecting gluten and reducing elasticity, reducing shrinkage and wrinkling of the dough after molding led to the improvement of the texture (reduction of hardness) of the produced cookies [32]. Also, Saraei and Karimi (2013) investigated the use of aged wheat flour and compared it with strong flours containing microbial protease enzyme and reported on the improvement of biscuit quality. These researchers stated that the use of ground flour in products that require weak flour (such as cookies, cookies, biscuits, crackers, cakes, etc.) can be effective if it is used correctly and not only does not lead to a decrease in texture quality, but also improves the texture and by creating a softer texture, it facilitates chewing and improves mouth feel. This was despite the fact that high levels of consumption of aged wheat flour without the presence of oxidizing additives and improvers such as ascorbic acid, citric acid, transglutaminase enzyme, etc. were not recommended in the formulation of baking products [33]. kneeling andAzar (2016) and kneeling andAzar (2017) investigated the use of wheat flour with 20.6% aging mixed with healthy wheat flour at zero, 10, 20, 30, 50 and 100% levels. In these studies, in order to increase the quality of aged wheat flour, various additives were used, such as diacetyl tartaric acid esters, mono and diglyceride, transglutaminase, citric acid and ascorbic acid. The results clearly showed that with an increase of more than 20% of aged wheat flour in the bread formulation, the dough yield, volume, height-to-width ratio of the bread decreased drastically and the stiffness of the texture increased, and only in the presence of additives, especially oxidizing compounds, the texture of the production samples can be improved [28 and 10]. Zheng et al. (2022) studied the function of transglutaminase enzyme and ascorbic acid on bread texture containing buckwheat flour. The results of these researchers showed that the presence of transglutaminase enzyme compared to ascorbic acid led to a more continuous paste structure. Both additives had a positive effect on the hardness, stickiness and cohesiveness of the bread texture [5]. Sheikholeslami et al. (2018) investigated the effect of the mixture of ascorbic acid and guar gum on the improvement of weakened wheat flour caused by the mixture with uncoated barley flour. In this research, zero, 10, and 20 percent levels of uncoated barley flour, zero, 1, 1.5, and 2 percent levels of guar gum and 200 ppm of ascorbic acid were used. The results of this research indicated that the presence of 2% of uncoated barley flour, 1% of guar gum and 200 ppm of ascorbic acid led to the improvement of the textural characteristics of bread, including the reduction of texture stiffness and maintaining the volume during the storage period [17]. Pourhaji and Sahraian (2017) used ascorbic acid at different levels in donut formulations. Ascorbic acid in concentrations of 50 and 100 ppm as a pro-oxidant affected the textural and appearance characteristics and finally increased the marketability of the product [34]. Sheikh al-Islami et al. (2008) used guar gum and ascorbic acid to improve the rheological properties and baking characteristics of aged wheat flour. The results showed that the addition of guar gum and ascorbic acid could independently and mutually improve the rheological properties of the dough and the texture quality of bread made from aged wheat, and the best effect was observed at the level of 0.5% guar gum and 200 ppm of ascorbic acid [35].

3-4-color

The results of color components ($L^*a^*b^*$) the level of production samples is presented in Table 3. As the results show, the presence of aged wheat flour in the cookie formulation led to a darker color of the production samples. So that the color component L^* and b^* Reduction and color component a^* increased Meanwhile, based on the results, it was found that the presence of ascorbic acid and the increase in its consumption level in the cookie formulation led to a lighter color of the production samples.

Table 3: The effect of bug-damage wheat and acid ascorbic on the crust color ($L^*a^*b^*$ values) of cookies.

Treatments	Bug-damage wheat (%)	Acid ascorbic (ppm)	Crust color		
			L^*	a^*	b^*
1 (Control)	-	-	59.67±0.93^{bc}	0.72±0.06^{d}	22.30±1.28^{b}
2	-	30	61.50±1.83^{ab}	0.72±0.08^{d}	19.50±0.56^{cde}
3	-	60	63.77±1.17^{a}	0.71±0.10^{d}	18.22±0.93^{and}
4	10	-	56.43±0.76^{of}	1.23±0.05^{bc}	22.83±0.80^{b}
5	10	30	59.53±1.01^{bcd}	1.19±0.02^{c}	20.90±0.60^{bcd}
6	10	60	59.93±0.56^{bc}	1.20±0.09^{c}	18.90±0.75^{of}
7	20	-	53.93±0.95^{if}	1.47±0.08^{a}	25.17±0.49^{a}
8	20	30	58.23±0.71^{cd}	1.43±0.09^{ab}	22.30±0.60^{b}
9	20	60	59.93±1.12^{bc}	1.44±0.04^{ab}	19.00±0.66^{of}
10	30	-	50.63±1.35^{g}	1.60±0.06^{a}	26.37±0.72^{a}
11	30	30	52.10±0.85^{fg}	1.54±0.08^{a}	22.17±0.86^{b}
12	30	60	54.03±0.91^{if}	1.51±0.03^{a}	21.77±0.68^{bc}

Different letters in each column represent significant difference from one another ($p<0.05$).

Among the characteristics of food, color is the most important visual characteristic, which is often related to the quality of food. The surface color of the food is the first qualitative feature that is evaluated by the consumer and can affect the acceptance of the food even before the food is put in the mouth. Consumers often judge nutritional value, safety, flavor, shelf life and other characteristics of food products based on color, and this is because in many cases there is a good correlation between color and the mentioned characteristics. The perception that arises from color depends on the observer and the conditions in which the color is seen [36, 37 and 38]. Color changes in food depend on several factors. Cooking temperature and time are among the most important factors affecting color changes, and the cause of these changes has been attributed to non-enzymatic browning reactions or the Maillard reaction that occurs in food. For this reason, if a substance is added to the main formulation of the food, which has a substrate effective on these reactions, the color changes will increase. As mentioned, the presence of aged wheat flour in the cookie formulation led to the darkening of the color of the produced samples. The reason for this can be explained as wheat age protease has a destructive effect on both gliadin and glutenin proteins, and as a result, they cause the production of smaller peptides and amino acids. Increasing the level of small peptides and free amino acids that are released by the action of proteases increases the intensity of the Maillard reaction and darkens the color [6]. Bonet et al. (2005) 1.2 times the amount of sulfhydryl groups [39] and Perez et al. (2005) reported about 6 times the amount of sulfhydryl groups in aged samples compared to healthy ones [40]. Although the aging enzyme is a protease and not a reductase, the amount of sulfhydryl groups in aging wheat has increased. The increase of sulfhydryl groups observed in damaged gluten indicates a molecular breakdown of gluten [41]. This increase in sulfhydryl groups can be attributed to the proteolytic activity of aged gluten, which makes hidden groups available, or increases the amount of low molecular weight proteins that have more cysteine amino acids, thus contributing to increasing the color intensity of baked products [39]. Therefore, there was this expectation by replacing healthy wheat flour with aged wheat flour with colored component L^* Reduction and color components a^* and b^* increase, and in other words, the color of samples containing aged wheat is darker. Also, the results of the present research clearly showed that the presence of ascorbic acid and the increase in its consumption level in the cookie formulation led to a brighter color of the produced samples. Ascorbic acid plays a role in brightening the color by oxidizing the pigments in the flour. Also, the smoothness and uniformity of the surface of the dough and baking product containing ascorbic acid should be considered as one of the effective factors in making the color brighter [5]. In this context Purlis and Salvadori (2009) stated based on the findings of their research that changes in the surface of the shell are responsible for its brightness, and regular and smooth surfaces have a greater ability to increase the amount of color component than wrinkled surfaces. L^* The shell or light reflection (luminosity) [42]. Kiyashko and Slideltsey (2022) studied the use of ascorbic acid as an improver with oxidation function in bread. The results of this research showed that the addition of 0.03% ascorbic acid (based on the weight of flour) made the samples brighter and glassy in color [16]. Pourhaji and Sahraian (2017) as a result of the presence of ascorbic acid in the donut formulation, increasing the color component L^* And in other words, they reported the brightness of the final product [34]. Mirzaei (2012) by formulating and evaluating the effect of several types of improvers (combination of ascorbic acid, xylanase enzyme and sodium stearoyl 2-lactylate emulsifier) on the quality of Sangak bread, stated that the bread sample containing the improver was brighter (reduction of redness and yellowness component) than the control sample [25].

5-3-sensory features

Based on the results of sensory evaluation and all the investigated parameters (form and shape, top surface characteristics, hardness and softness of texture, porosity and porosity and chewability, smell and taste) (Table 4) and finally general acceptance (Figure 2), it can be said that the sample containing 10% of aged wheat flour and 30 ppm ascorbic acid (first priority), the control sample (the sample without aged wheat flour and ascorbic acid) (second priority) and the sample containing 20% of aged wheat flour and 60 ppm of ascorbic acid (third priority) were the three best samples of this research. But since the purpose of this research was to replace a part of healthy wheat flour with aged wheat flour and add value, the samples containing aged wheat flour (first and third priority) are introduced as the best samples in terms of sensory characteristics.

Table 4: The effect of bug-damage wheat and acid ascorbic on the sensory properties of cookies.

Treatments	Bug-damage wheat (%)	Acid ascorbic (ppm)	Sensory properties		
			Form and Shape	Surface	Subsurface
1 (Control)	-	-	3.70±0.67^{bc}	4.10±0.74^{ab}	4.00±0.47^{a}
2	-	30	3.20±0.63^{cd}	3.50±0.53^{abcd}	3.50±0.53^{ab}
3	-	60	2.70±0.67^{def}	2.60±0.69^{of}	2.80±0.63^{bc}
4	10	-	3.10±0.57^{cde}	3.70±0.67^{abc}	3.50±0.71^{ab}
5	10	30	4.60±0.52^{a}	4.40±0.70^{a}	4.00±0.67^{a}
6	10	60	3.70±0.48^{bc}	3.30±0.67^{bcd}	3.50±0.53^{ab}
7	20	-	2.30±0.48^{if}	2.90±0.57^{cde}	2.60±0.52^{c}
8	20	30	3.00±0.67^{cdef}	3.80±0.42^{abc}	3.30±0.48^{abc}
9	20	60	4.10±0.57^{ab}	4.10±0.88^{ab}	3.90±0.326^{a}
10	30	-	2.20±0.42^{f}	2.30±0.48^{and}	2.50±0.71^{c}
11	30	30	2.60±0.52^{def}	3.10±0.57^{cde}	3.20±0.42^{abc}
12	30	60	3.20±0.63^{cd}	3.40±0.69^{bcd}	3.20±0.42^{abc}
Treatments	Bug-damage wheat (%)	Acid ascorbic (ppm)	Sensory properties		
			Firmness and Softness	Chewiness	Odor and Taste
1 (Control)	-	-	3.80±0.42^{ab}	3.70±0.48^{ab}	3.60±0.52^{a}
2	-	30	3.60±0.52^{abc}	3.40±0.52^{abc}	2.40±0.52^{bc}
3	-	60	3.50±0.53^{abc}	2.60±0.70^{def}	1.30±0.48^{d}
4	10	-	3.90±0.32^{a}	2.90±0.57^{cdef}	2.30±0.48^{bc}

5	10	30	3.90 ± 0.57^{a}	3.80 ± 0.79^{a}	3.60 ± 0.52^{a}
6	10	60	4.00 ± 0.63^{a}	2.90 ± 0.32^{cdef}	2.20 ± 0.63^{bc}
7	20	-	3.80 ± 0.63^{ab}	2.30 ± 0.48^{if}	2.00 ± 0.71^{bcd}
8	20	30	3.90 ± 0.57^{a}	3.00 ± 0.47^{bcde}	2.10 ± 0.32^{bcd}
9	20	60	3.70 ± 0.67^{ab}	3.20 ± 0.42^{ab}	2.70 ± 0.67^{b}
10	30	-	2.50 ± 0.71^{d}	2.20 ± 0.42^{f}	1.60 ± 0.70^{cd}
11	30	30	2.80 ± 0.42^{cd}	2.50 ± 0.53^{def}	2.00 ± 0.47^{bcd}
12	30	60	3.00 ± 0.47^{bcd}	2.60 ± 0.52^{def}	2.10 ± 0.31^{bcd}

Different letters in each column represent significant difference from one another ($p<0.05$).

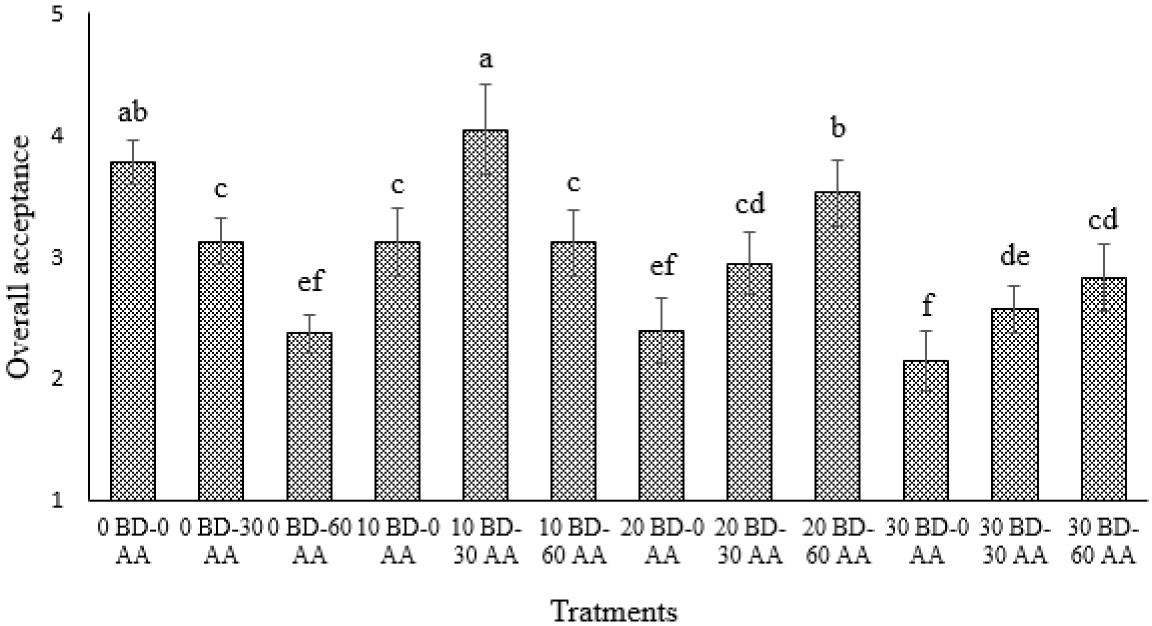

Fig 2: The effect of bug-damage wheat (BD) and acid ascorbic (AA) on the overall acceptance of cookies. Different letters represent significant difference from one another ($p<0.05$).

Koliandris et al. (2008) reported that the perception of smell and taste and the release of their producing substances depends on the type of sample tissue and in tissues that are more continuous and the texture is pleasant to the consumer or taste evaluators, the perception of smell and taste is more [43]. Boland and colleagues (2004) justified this in another way and believed that the interactions between odor and taste-producing substances happened better in products with appropriate texture and structure, which leads to an increase in good mouthfeel and the release of more flavor-producing substances. Therefore, it can be justified that the samples that had a better texture score (texture hardness and softness, porosity and chewability) had more smell and taste scores. As the results showed, high levels of consumption of aged wheat flour, especially the 30% level, led to a decrease in the quality of the cookies produced, and even the 20% level of this flour only in the presence of ascorbic acid, especially at the level of 60 ppm, had a positive effect on the sensory characteristics. Several studies have been conducted on the use of aged wheat flour in the formulation of baking products and its positive and negative effects on the quantity and quality of the final product [44]. kneeling and Azar (2023) reported that the use of aged wheat flour without the presence of oxidants in the formulation of baking products caused the creation of unfavorable texture, chewability, form and shape, color, smell and taste, as a result of which a decrease in quality was observed [11]. Akramian et al. (1402) used wheat flour with 100% aging in the production of waffles. The results of these researchers showed that the highest overall acceptance score in sensory evaluation was observed in the sample containing 0.5% aged wheat flour (wheat with 100% aging). In this research, it was reported that the presence of aged wheat flour in the products containing weak wheat flour has a positive effect and not only the quality does not decrease, but the characteristicSensory levels increase [6]. There are also reports of improvement of sensory characteristics as a result of the presence of ascorbic acid in the formulation of baking products containing weak flour or aged wheat flour. In the findings of these studies, it is stated that the bread containing ascorbic acid had a better aroma and taste. Kiyashko and Slideltsey (2022) studied the application of ascorbic acid as an improver with oxidizing function on the sensory characteristics of bread. The results of this research showed that adding 0.03% of ascorbic acid (based on the weight of flour) to the formulation improved the aroma and taste of the bread and made the texture softer and the mouth feel good [16]. Zeidvand et al. (2023) investigated different levels (zero, 0.25 and 0.50%) of lactic acid, ascorbic acid and azodicarbon Omid on the quality characteristics of Sangak bread. Based on the findings, it was found that the presence of additives used in bread formulation improved sensory characteristics (taste, smell, color and texture) and reduced staleness [12].

4-Conclusion

This research aims to introduce aged wheat flour as one of the agricultural wastes into the food cycle, this flour was substituted for healthy wheat flour in the formulation of traditional Zaboli cookies, and ascorbic acid was used as an oxidizer with a positive effect on the quantity and quality of poor flours to compensate for the damages caused by aging. The results showed that by replacing healthy wheat flour with aged wheat flour, the moisture level of cookies decreased. This was despite the fact that ascorbic acid was successful in maintaining the moisture content of the production samples during the cooking process and after. Also, the results showed that the sample containing 10% aged wheat flour and 30 ppm ascorbic acid had the highest specific volume and the lowest texture hardness (during one month of storage) compared to other manufactured cookies. The presence of aged wheat flour in the cookie formulation led to the darkening of the color of the produced samples. This was while the findings clearly showed the presence of ascorbic acid and increasing its consumption level in the cookie formulation led to a brighter color of the production samples. Finally, based on the results of the sensory evaluation and all the investigated parameters (form and shape, upper and lower surface characteristics, hardness and softness of the texture, porosity and porosity and chewability, smell and taste) and the overall acceptance score, it can be said that the sample containing 10% of aged wheat flour and 30 ppm of ascorbic acid (first priority), the control sample (the sample without aged wheat flour and ascorbic acid) (second priority) and the sample containing 20% of wheat flour Aged and 60 ppm ascorbic acid (third priority) were the three best samples of this study. But since the purpose of this research was to replace a part of healthy wheat flour with aged wheat flour and add value, the samples containing aged wheat flour (first and third priority) are introduced as the best samples in terms of sensory characteristics.

5- Resources

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مقاله علمی_پژوهشی

بررسی اثر آرد گندم سن‌زده و اسید آسکوربیک بر ویژگی‌های فیزیکوشیمیایی و حسی کلوچه سنتی زابلی

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چکیده

گندم سن‌زده یکی از ضایعات کشاورزی است که با ورود به چرخه انسانی کمک قابل توجهی به صنعت فراورده‌های پخت خواهد شد. از این رو در پژوهش حاضر، آرد گندم سن‌زده در سطوح ۱۰، ۲۰ و ۳۰ درصد جایگزین آرد گندم سالم در فرمولاسیون کلوچه سنتی زابلی شد و برای جبران خسارات ناشی از سن‌زدگی از اسید آسکوربیک در سطوح ۳۰ و ۶۰ پی‌پی‌ام استفاده گردید. نتایج نشان داد میزان رطوبت، خاکستر، چربی، پروتئین، عدد فالینگ و عدد زلنی آرد گندم سالم و سن‌زده نتواست شاخص مناسبی برای تشخیص سن‌زدگی باشد. این در حالی بود که میزان گلوتن مرطوب و اندیس گلوتن از پارامترهای تاثیرگذار برای تشخیص و تفکیک گندم سالم و سن‌زده بودند و میزان گلوتن و اندیس گلوتن در نمونه آرد حاصل از گندم سالم بیشتر بود. همچنین نتایج نشان داد با جایگزینی آرد گندم سالم با سن‌زده از میزان رطوبت کلوچه‌ها کاسته شد. اسید آسکوربیک در حفظ رطوبت کلوچه‌ها طی فرایند پخت و پس از آن موفق عمل نمود. علاوه بر این براساس نتایج حاکی از آن بود که نمونه حاوی ۱۰ درصد آرد گندم سن‌زده و ۳۰ پی‌پی‌ام اسید آسکوربیک دارای بیشترین حجم مخصوص و کمترین سفتی بافت طی یک ماه نگهداری بود. حضور آرد گندم سن‌زده و اسید آسکوربیک در فرمولاسیون به ترتیب منجر به تیره و روشن‌تر شدن رنگ نمونه‌ها شد. براساس امتیاز پذیرش کلی مشخص شد نمونه حاوی ۱۰ درصد آرد گندم سن‌زده و ۳۰ پی‌پی‌ام اسید آسکوربیک (اولویت اول)، نمونه شاهد (فاقد آرد گندم سن‌زده و اسید آسکوربیک) (اولویت دوم) و نمونه حاوی ۲۰ درصد آرد گندم سن‌زده و ۶۰ پی‌پی‌ام اسید آسکوربیک (اولویت سوم) سه نمونه برتر بودند. اما از آن جا که هدف کاربرد آرد گندم سن‌زده بود، نمونه‌های حاوی آرد گندم سن‌زده (اولویت اول و سوم) به عنوان بهترین نمونه‌ها به لحاظ ویژگی‌های تکنولوژیکی و حسی معرفی می‌شوند.