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Effect of Partial Replacement of Oats in Improving the Chemical Composition and Quality Characteristics of Frozen Beef Burger

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ABSTRACT

This study aimed to investigate the effect of partial replacement of oat powder at an addition rate of (4%) and at a replacement rate of (50%) of the filler material, which is wheat flour, to produce beef burgers stored in the freezer at a temperature of (-18 ± 2) degrees Celsius during the storage period for (45) for three periods (1, 15, 45) days during which the chemical and physical characteristics were examined and monitored. The study was conducted on two treatments of beef burgers, the first treatment (T1) is the control without replacement and the second treatment (T2) was partially replaced with oats at a rate of (50%). The results showed a significant increase (P<0.05) in the percentage of protein, ash and water holding capacity (WHC) for the replacement treatment (T2) compared to the control treatment (T1) with a significant decrease (P<0.05) in the values of total volatile nitrogen (TVN), the percentage of free fatty acids (FFA), loss during thawing and loss during cooking for the treatment Replacement (T2) compared to the control treatment (T1) and the stability and stability of the level of each of the Ph value, peroxide values (PV) and thiobarbituric acid (TBA) concentration. within the standard limits compared to the control treatment (T1). The results showed a clear and noticeable improvement for all the studied traits.

Keywords: free fatty acids, meat processing, peroxide values, WHC.

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INTRODUCTION

The significant increase in demand for meat products, in addition to the intense competition in the market, has led to the emergence of new and innovative methods in this industry. The global meat industry seeks to develop more advanced production and manufacturing methods to meet the increasing and changing needs of consumers (Rubeii et al., 2023). In addition to the increasing consumer demand for beef, characteristics such as good flavor, health value, safety, and reasonable prices remain the most important factors that the meat industry focuses on to meet customer expectations (Al-Salam et al., 2024). Meat producers are developing methods to extend the shelf life of products while maintaining their high quality and ensuring their nutritional safety for consumers. (Radhi et al., 2025) Meat is a rich source of high-quality proteins, vitamins, and minerals, but it lacks dietary fiber, which is an essential element for human health (Elsorougy, 2025). Fiber can be obtained from sources such as grains, legumes, fruits, vegetables, and their by-products, which have multiple nutritional, functional, and health benefits. Therefore, these fibers can be added to meat products to improve their physical and chemical properties, enhance their nutritional composition, and improve their texture and taste, making them more beneficial and acceptable to consumers Plant proteins rich in nutritional value can be used in the manufacture of meat products, which enhances their nutritional value while maintaining consumer satisfaction and continued demand for these products. Burgers have become a popular global dish, characterized by their great diversity in recipes and ingredients. Among these innovations,

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hybrid burgers have emerged, combining meat and plant proteins, reducing saturated fat and offering a healthier option (Ramachandraiah , 2025). There is a close relationship between the amount and quality of fat we eat and the incidence of common diseases such as heart disease, atherosclerosis and obesity. As a result, consumers have become more aware and interested in choosing low-fat foods, especially when it comes to meat products. Low-fat burgers are more stable against oxidation than other types (Saber et al., 2023). The quality of low-fat meat products can be improved by using fat substitutes, where fat is replaced with protein-based, carbohydrate-based or alternative fats. This approach is an effective alternative to reducing the fat content of meat, especially when using non-meat ingredients, as it provides functional benefits and high nutritional values, which helps improve the texture and flavor of the product while maintaining its nutritional quality (Abolgasem and Salama, 2023). Oats (Avena sativa L.) are annual herbaceous plants belonging to the Gramineae family, and are widely cultivated in many regions around the world, such as the European Union, Canada, the United States, Australia, etc. (Abood, 2020; Li et al., 2023). Cereals are mainly cultivated for their nutritious and edible grains, which are widely consumed around the world. Oats are the sixth most important cereal crop in the world, after wheat, maize, rice, barley, and sorghum. Oats have great potential to be a superfood, offering a variety of health benefits and distinctive nutritional properties. They contain all the essential nutrients, such as carbohydrates, proteins, vitamins, minerals, and antioxidants, in addition to soluble fiber. Due to their high nutritional value and health benefits, oats have increased significantly in popularity in recent years (Ihsan et al., 2022). Oats are a valuable and affordable raw material, making them ideal for widespread use in the food industry. These grains deserve great attention in the fields of research, processing, and food applications, as they can effectively contribute to improving people's health. The wider use of oats and their compounds, such as beta-glucan, opens up new avenues for enhancing health benefits. In addition, there is a growing demand for food products with high nutritional value and health-promoting properties, making oats an ideal choice in this area (Leszczyńska et al., 2023). It also has a high nutritional and health value, and is considered one of the most important global cereal crops. What distinguishes it in particular is its high content of beta-glucan, a substance that may not be available in the same quantities in other types of grains (Mao et al., 2022). The demand for foods rich in nutritional value and subjected to minimal processing is increasing, especially those with clear health benefits. Whole oats are one of the most prominent of these foods, as clinical studies show its role in the prevention and treatment of many health problems, such as high blood pressure Atherosclerosis, obesity, and digestive disorders, in addition to reducing the risk of some types of cancer associated with diet and other health conditions (Darewicz et al., 2022). It is considered one of the abundant plant sources in Iraq and its abundance and cheap prices in local markets and the many benefits it has, so the study worked to follow the changes that occur in the chemical composition and to improve the qualitative characteristics of beef burger.

MATERIALS AND METHODS

This study was conducted in the Faculty of Agriculture Faculty / University of Baghdad in 2025, and calf cut was purchased from the local markets of Baghdad and the physical separation process of the thigh was carried out to separate the meat from the fat and bone, after storing it in the refrigerator for 24 hours at a temperature of 4 degrees Celsius, then the meat was cut into small pieces of 2 cm3 to facilitate the mincing process. The lean beef was minced twice using a clamp with holes diameters (8 mm and then 5 mm).800 grams of meat add 100 grams of fat. Oats, wheat, salt and spices were obtained for the study from the local markets of Baghdad Governorate. After grinding and smoothing them, they were stored in the freezer at a temperature of -18 C until use. All the materials used were mixed manually using sterile medical gloves for each treatment. After calculating the quantities of materials and preparing them according to

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Table (1), burger patties weighing 100 grams were manufactured using locally made molds. Then the patties were placed in polyethylene bags, and a piece of nylon was separated from each other and closed well. They were stored in the freezer at a temperature of (-18 ± 2) C for 45 day. The changes in some chemical components and qualitative and physical properties were monitored during storage periods of (A. O. A. C., 2000; Ibrahim, 2023) day, where the percentage of moisture, protein, fat and ash were estimated according to the methods mentioned in (A. O. A. C., 2000), and the Ph was estimated based on (Wali et al., 2025), and the percentage of weight loss during cooking for burgers cooked using a hot plate according to method of (Mir et al., 2023) and the peroxide values were calculated. (PV) and values of Thio barbituric acid (TBA), total volatile nitrogen (TVN), free fatty acids (FFA) according to (Ali Altaee et al., 2025), water holding capacity (WHC), and estimation of the Thaw loss (Al-Salmany, and. AL-Rubeii, 2020). The data were statistically analyzed using the S A S program (SAS, 2018) to study the effect of different treatments on the studied traits according to a completely randomized design (CRD), and the significant differences between the averages were compared using the least significant difference (LSD) test.

Table 1. Proportions of materials used in preparing the beef burger

Treatment	meat Calf gram	Fats Animal gram	precise Wheat gram	precise Oats gram	Salt %	Garlic %	Spices %
control T1	800	100	100	---	1.5	0.25	0.5
Oats replacement ratio %50 T2	800	100	50	50	1.5	0.25	0.5

RESULTS AND DISCUSSION

Table (2) shows the effect of partial replacement of oats on the chemical composition of beef burger. It is noted that there is a non-significant difference (P≤0.05) in the moisture percentage of beef burger samples for the control treatment (T1) and the replacement treatment (T2) throughout the storage period, as the highest value for the control treatment (T1) was 75.05% at (1) day of freezing storage and the lowest value was 70.13% at (45) days of freezing storage, which shows a significant decrease (P≤0.05) in the moisture percentage of the control treatment (T1). As for the replacement treatment (T2), the highest value for the moisture percentage was 72.97% at (1) day of freezing storage and the lowest percentage was 71.58% at (45) day of freezing storage, which was a non-significant decrease, unlike the control treatment (T1), which had a lower percentage of it. This is due to the effect of the replacement ratios of the fillers used that work to tighten and bind water to the rest of the burger components. The factory and thus the high moisture percentage, (Ali Altaee et al., 2025) indicated that the moisture percentage increases with the increase in the concentration from plant extracts alternative, fava bean powder and soy protein, in the factory turkey burger. It is also noted from the data of Table (2) that there is a significant difference (P≤0.05) in the percentage of protein within one treatment, which is the control treatment (T1), with the advancement of the freezing storage period, and there are insignificant differences (P≤0.05) between the control treatment (T1) and the replacement treatment (T2), where the highest percentage for the control treatment (T1) was 20.83% at (45) days of freezing storage, and the lowest percentage for the control treatment (T1) was 18.93% at (1) day of freezing storage, while the highest percentage for the replacement treatment (T2) was 22.57% at (45) days of freezing storage, and the lowest percentage for the replacement treatment (T2) was 19.79% at (1) day of freezing storage, and the reason is that oats added protein percentage in addition to their ability to retain water, and thus will be reflected in the percentages of other components, while Tkaczewska et al.,(2024) noted a decrease in the percentage of protein in processed meat products with an increase in the percentage of vegetable additions including bran, bread and flour. It was noted from Table (2) that there were no significant differences (P≤0.05) between the control

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treatment (T1) and the replacement treatment (T2) throughout the freezing storage period and a slight increase in the percentage of fat for both treatments, as the highest value for the control treatment (T1) was 2.61% at (45) days of freezing storage and the lowest value for the control treatment (T1) was 2.53% at (1) day of freezing storage, while the highest percentage for the replacement treatment (T2) was 3.05% at (45) day of freezing storage and the lowest percentage for the replacement treatment (T2) was 2.89% at (1) day of freezing storage. The reason for the increase in the percentage of fat is attributed to the decrease in the moisture percentage with the advancement of the freezing storage period, as Mahfouz (2021) noted that replacing fats with red bean powder contributed to reducing the total percentage of fat in the burger, and also led to improving its properties in general. This approach relies on using plant-based ingredients as healthy alternatives to fats, making the burger less fatty and more beneficial. Table (2) also shows that there was a significant increase and differences (P≤0.05) for ash between the percentage of the control treatment (T1) and the replacement treatment (T2) throughout the freezing storage period, where the highest percentage for the control treatment (T1) was 1.95% at (45) days of freezing storage and the lowest percentage for the control treatment (T1) was 1.82% at (1) day of freezing storage, while the highest percentage for the replacement treatment (T2) was 2.44% at (45) days of freezing storage and the lowest percentage for the replacement treatment (T2) was 2.37% at (1) day of freezing storage. The reason for this is the decrease in the moisture content during the storage period and the added amount of oats and the fibers it contains is the reason for the increase. These results are consistent with AL- Shamery (2016), who noted that adding a larger amount of wheat germ powder led to an increase in the ash percentage in the burger, which reflects an increase in its mineral percentage. This confirms the role of plant ingredients, such as wheat germ powder, in enhancing the nutritional percentage of the product.

Table 2. Effect of oat substitution (4%) on the chemical composition of frozen beef burger

Chemical composition	Raw materials	Freezing storage time / day			LSD value
		1	15	45	
Moisture	control T1	75.05	73.23	70.13	3.89 *
	Oats replacement ratio 4% T2	72.97	72.65	71.58	2.94 NS
	LSD value	3.59 NS	3.08 NS	2.76 NS	---
Protein	control T1	18.93	19.56	20.83	1.93 *
	Oats replacement ratio 4% T2	19.79	20.67	22.57	2.37 *
	LSD value	1.82 NS	1.55 NS	2.06 NS	---
Fat	control T1	2.53	2.55	2.61	0.431 NS
	Oats replacement ratio 4% T2	2.89	2.92	3.05	0.296 NS
	LSD value	0.502 NS	0.517 NS	0.487 NS	---
Ash	control T1	1.82	1.86	1.95	0.287 NS
	Oats replacement ratio 4% T2	2.37	2.39	2.44	0.302 NS
	LSD value	0.416 *	0.445 *	0.429 *	---

.(P≤0.05) *

Table (3) shows the effect of partial replacement of oats on the tests and chemical characteristics of frozen-stored burger discs. It is noted that there were no significant differences (P≤0.05), but a slight increase in the peroxide value (PV) (milliequivalents/kg fat) for meat burger samples, whether for the control treatment (T1) or the replacement treatment (T2) throughout the freezing storage period, where the highest value for the control treatment (T1) was 5.43 mequivalents/kg at (45) days of freezing storage and the lowest value was 5.10 mequivalents/kg at (1) day of freezing storage, while the replacement treatment (T2) had the highest value of 5.24 mequivalents/kg at (45) days of freezing

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storage and the lowest value was 5.15 mequivalents/kg at (1) day of freezing storage. Thus, the results show a slight decrease and stability in the peroxide value (PV). (milliequivalent/kg fat) for the replacement treatment (T2) within the standard limits and improving the quality and sensory characteristics. The reason for the decrease is due to the content of oats and chia of substances that have antioxidant activity and thus reduce the oxidation of fats. This is reflected in the decrease in peroxide values (PV) as noted by AL-Salam and Ayad (2024). Table (3) shows the effect of partial replacement of oats on the values of thiobarbituric acid (TBA) (mg malondialdehyde/kg meat) without any significant differences (P≤0.05) between the control treatment (T1) and the replacement treatment (T2) throughout the freezing storage period, as the highest value for the control treatment (T1) was 0.59 (mg malondialdehyde/kg meat) at (45) days of freezing storage and the lowest value was 0.39 (mg malondialdehyde/kg meat) at (1) day of freezing storage, which had significant differences (P≤0.05) for the same treatment during the freezing storage period. As for the replacement treatment (T2), its highest value was 0.52 (mg malondialdehyde/kg meat) at (45) days of freezing storage and the lowest value was 0.46 (mg malondialdehyde/kg meat). Meat after (1) day of freezing storage, which is a slight increase that does not affect the quality or sensory characteristics. The reason for the increase in concentration with the advancement of storage is due to the increase in the concentration of malondialdehyde, which is a product of the oxidation of fats and the decomposition of peroxides. These results agreed with AL-Esawi and Al-Farraji, (2016). Table No. (3) also shows the partial effect of oats on the values of total volatile nitrogen (TVN) (mg N/100/g meat) for beef burger. It is noted that there were significant differences (P≤0.05) between the control treatment (T1) and the replacement treatment (T2) during two periods of freezing storage, which are (15, 45) days, and there were significant differences (P≤0.05) for the control treatment (T1) throughout the storage period, as the highest concentration for the control treatment (T1) was 6.82 (mg N/100/g meat) at (45) days of freezing storage, and the lowest concentration for the control treatment (T1) was 5.85 (mg N/100/g meat) at (1) day of freezing storage, while the highest concentration for the replacement treatment (T2) was 5.40 (mg N/100/g meat) at (1) day of freezing storage. The lowest concentration for the replacement treatment (T2) was 5.38 (mg N/100/g meat) at (15) days of freezing storage, which indicates a significant decrease in the concentration of total volatile nitrogen (TVN) for the replacement treatment (T2) due to slight protein degradation resulting from the activity of the autolytic enzymes of the protein. This is consistent with Miao (24) that the concentration of total volatile nitrogen (TVN) increases with increasing storage time and within the permissible limits and did not affect the quality and decreased significantly in the treated sample. The table shows the effect of partial replacement of oats on the percentage of free fatty acids (FFA) of beef burger. It is noted that there are significant differences (P≤0.05) between the control treatment (T1) and the replacement treatment (T2) at (45) days of freezing storage and a decrease in the percentage of free fatty acids (FFA) in the replacement treatment (T2). It is also noted that there are significant differences (P≤0.05) and an increase in the percentage of free fatty acids (FFA) for the control treatment (T1) during the period (1, 15, 45) days of freezing storage, where the highest percentage for the control treatment (T1) was 0.65% at (45) days of freezing storage and the lowest percentage for the control treatment (T1) was 0.46% at (1) day of freezing storage, while the highest percentage for the replacement treatment (T2) was 0.44% at (45) days of freezing storage and the lowest percentage for the replacement treatment (T2) 0.38% at (1) day of freezing storage, indicating a decrease in the percentage of free fatty acids (FFA) due to the oats containing antioxidants, which is similar to what Al-Salam and Ayad (2024) observed, that the replacement treatments contain phenolic compounds and flavonoids that act as antioxidants, so the percentage of free fatty acids (FFA) decreases, thus maintaining the quality and improving the qualitative characteristics of the product.

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Table 3. Effect of substitution of oats (4%) on some characteristics of frozen beef burger

Chemical tests	Raw materials	Freezing storage time / day 1	15	45	LSD value
PV (mEq/kg fat)	T1 control	5.10	5.18	5.43	P.342 NS
	Oats replacement ratio T2 %50	5.15	5.17	5.24	0.292 NS
	LSD value	0.349 NS	0.294 NS	0.307 NS	----
TBA mg MDA/kg	T1 control	0.39	0.43	0.59	0.137 *
	Oats replacement ratio T2 %50	0.46	0.47	0.52	0.129 NS
	LSD value	0.097 NS	0.084 NS	0.078 NS	---
TVN (N / 100 / GM meat)	T1 control	5.85	6.12	6.82	0.772 *
	Oats replacement ratio T2 %50	5.40	5.38	5.39	0.298 NS
	LSD value	0.626 NS	0.671 *	0.824 *	---
FFA (%)	T1 control	0.46	0.51	0.65	0.182 *
	Oats replacement ratio T2 %50	0.38	0.39	0.44	0.076 NS
	LSD value	0.091 NS	0.134 NS	0.174 *	---

*(P≤0.05)

Table No. (4) shows the effect of partial replacement of oats on the Ph values of frozen beef burger. It is noted that there were no significant differences (P≤0.05) and a slight increase in the Ph in both the control treatment (T1) and the replacement treatment (T2) throughout the freezing storage period. The highest value for the control treatment (T1) was 5.93 at a period of (45) days of freezing storage and the lowest value for the control treatment (T1) was 5.56 at a period of (1) day of freezing storage, while the highest value for the replacement treatment (T2) was 5.73 at a period of (45) days of freezing storage and the lowest value for the replacement treatment (T2) was 5.52 at a period of (1) day of freezing storage. The values of the replacement treatment (T2) decreased slightly from the values of the control treatment (T1) during the freezing storage periods and within the standard limits of the Ph, thus maintaining the quality and qualitative characteristics. The physical characteristics of the product and the reason for the oats containing minerals and their high absorbability were similar to those of AL-Salam (7). Table (4) shows the effect of partial replacement of oats on the water holding capacity (WHC) of frozen beef. It is noted that there is an increase and significant differences (P≤0.05) in the water holding capacity (WHC) in the replacement treatment (T2) at a period of (45) days of freezing storage and a significant decrease (P≤0.05) in the water holding capacity (WHC) in the control treatment (T1) throughout the freezing storage periods (1, 15, 45) respectively, where the highest value for the control treatment (T1) was 17.37 at a period of (1) day of freezing storage and the lowest percentage for the control treatment (T1) was 14.48 at a period of (45) days of freezing storage, which indicates a significant decrease (P≤0.05) in the water holding capacity (WHC) with the advancement of the storage period, while the highest percentage for the replacement treatment (T2) was 17.83% at a period of (1) day. From freezing storage and the lowest percentage of the replacement factor (T2) 16.82% at a period of (45) days of freezing storage and the reason for the loss and low water retention is the effect of freezing and protein deterioration and loss of part of the

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meat's water-holding capacity (WHC) and the addition of oats reduced the loss percentage and works to absorb and retain water and reduce the loss during the freezing storage process because it contains fibers such as beta-glucan and the high Ph increases the water-holding capacity (WHC) and these results are close to AL-Salmany (2020). Table No. (4) Shows the effect of partial replacement of oats on the percentage of loss during thawing of beef burger. It is noted that there is a decrease and a significant difference (P≤0.05) in the percentage of loss during thawing for the replacement treatment (T2) and the control treatment (T1) during the freezing storage period (15,45) days, and there is a significant increase (P≤0.05) in the percentage of loss during thawing with the advancement of the freezing storage period (1,15,45) for the control treatment (T1), where the highest percentage for the control treatment (T1) was 4.98% at a period of (45) days of freezing storage, and the lowest percentage for the control treatment (T1) was 3.86% at a period of (1) day of freezing storage, and thus there is an increase in the percentage of loss during thawing, while the highest percentage for the replacement treatment (T2) was 3.75% at a period of (1) day of freezing storage, and the lowest percentage for the replacement treatment (T2). 3.62% at a period of (45) days of freezing storage, and thus a decrease in the percentage of loss during thawing with the advancement of freezing storage periods. The reason for this is that oats have the ability to absorb and retain water due to their high content of dietary fibers, and it works to form small ice crystals during freezing, thus preserving meat proteins from major changes, and thus improving the quality and qualitative and physical characteristics. These results are similar to AL-Shamry (2016). Table No. (4) shows the effect of partial replacement of oats on the percentage of loss during cooking of beef burger and shows a decrease and significant differences (P≤0.05) in the percentage of loss during cooking in the replacement treatment (T2) compared to the control treatment (T1) and significantly throughout the periods (1, 15, 45) days of freezing storage, where the highest value for the control treatment (T1) was 27.46% at a period of (45) days of freezing storage and the lowest value for the control treatment (T1) was 25.82% at a period of (1) day of freezing storage and there were no significant differences for the same treatment according to the different periods (1, 15, 45) days of freezing storage, while the highest percentage for the replacement treatment (T2) was 20.47% at a period of (45) days of freezing storage and the lowest value for the replacement treatment (T2) was 19.78% at a period of (1) day of freezing storage and that this decrease and significant difference (P≤0.05) The percentage of loss during cooking in the replacement treatment throughout the freezing storage periods improves the quality and maintains the qualitative and physical characteristics of the product. The reason for this is that adding oats increases the water holding capacity (WHC) and retains and stabilizes water and fat in the meat mixture because it contains fibers and proteins that reduce the loss during cooking the longer the freezing period, as indicated by AL-Shamry (2016).

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Table 4. Effect of oat substitution (4%) on some physical properties of frozen beef burger

Physical properties	Raw materials	Freezing storage time / day 1	15	45	valueLSD ---
pH (%)	controlT1	5.56	5.64	5.93	0.429 NS
	Oats replacement ratio %50T2	5.52	5.58	5.73	0.398 NS
	valueLSD	0.329 NS	0.302 NS	0.337 NS	---
WHC (%)	controlT1	17.37	16.58	14.48	2.274 *
	Oats replacement ratio %50T2	17.83	17.38	16.82	1.270 NS
	valueLSD	1.04 NS	1.39 NS	2.19 *	---
Thaw loss (%)	controlT1	3.86	4.26	4.98	0.604 *
	Oats replacement ratio %50T2	3.75	3.69	3.62	0.314 NS
	valueLSD	0.328 NS	0.433 *	0.672 *	---
Loss during Cooking (%)	controlT1	25.82	26.12	27.46	2.155 NS
	Oats replacement ratio %50T2	19.78	19.89	20.47	1.962 NS
	valueLSD	2.725 *	3.517 *	2.908 *	----

.(P≤0.05) *

CONCLUSIONS

From the results of this study, we conclude that oat powder can be used as a high protein filler in the manufacture of frozen beef burgers, maintaining their chemical, qualitative and physical characteristics, improving quality, reducing cost and preventing undesirable changes during 45 days of freezing storage. Therefore, we recommend using oats as a low-cost filler and quality enhancer in other meat products.

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تأثير الاستبدال الجزئي للشوفان في تحسين التركيب الكيميائي والصفات النوعية للبيركر البقري المجمد

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المستخلص

هدفت الدراسة الى الاستبدال الجزئي لمسحوق الشوفان بنسبة أضافة (4%) وبمعدل استبدال (50%) من المادة المالئة وهي دقيق الحنطة لإنتاج البيرجر البقري المخزن بالتجميد على درجة حرارة (-18 ±2) درجه مئوية خلال مدة الخزن لمدة (45) بواقع ثلاث مدد (1،15،45) يوم تم خلالها فحص ومراقبة الصفات الكيميائية والنوعية والفيزيائية ، واجرية الدراسة على معاملتين لمنتج البيركر البقري المعاملة الأولى (T1) هي السيطرة بدون استبدال والمعاملة الثانية (T2) تم استبدال جزئي للشوفان بنسبة (50%) وقد أظهرت النتائج وارتفاع معنوي(P<0.05) في نسبة البروتين والرماد وقابلية حمل الماء (WHC) لمعاملة الاستبدال (T2) مقارنة بمعاملة السيطرة (T1) مع انخفاض معنوي (P<0.05) بقيم النتروجين الكلي المتطاير(TVN) وقيمة الاحماض الدهنية الحرة (FFA) والفقد اثناء التذويب والفقد اثناء الطبخ لمعاملة الاستبدال (T2) مقارنة بمعاملة السيطرة (T1) وثبات واستقرار مستوى كل من نسبة الاس الهيدروجيني (PH) وقيم البيروكسيد(PV) وقيم حامض الثايوباريوثيوريك (TBA) ضمن الحدود القياسية مقارنة بمعاملة السيطرة (T1). اذ أظهرت النتائج تحسن واضح وملحوظ لجميع الصفات المدروسة.

كلمات مفتاحية: الأحماض الدهنية الحرة، تصنيع لحوم، قيم البيروكسيد، قابلية حمل الماء.