Effect of Adding Rice Bran as Source of Fiber on Quality Properties of Low-fat Meatballs Stored in the Freezer

Nawar A. A .Al-Ghabawi and Aum El-Bashar H.J. Al-Mossawi
Food Sciences, College of Agriculture, University of Basra
Emails/ Psedpgs.nawar.abdulrazaq@uobasrah.edu.iq and aum_elbashar.jaber@uobasrah.edu.iq

Abstract
The study aimed to improve the qualitative properties of low-fat meatballs by adding rice bran to its high fiber content, which reached 40.27%. The meatballs were prepared in four treatments: the first was a control treatment, the second was added to rice bran at a rate of 10%, the third was at a rate of 20%, and the fourth was at a rate of 30%. The chemical content was studied and the product was stored the product in a freezer (-18 ± 2) for 90 days. Some qualitative characteristics were monitored: fat, fiber, cholesterol, water-holding capacity, Thawing loss, cooking loss, shrinkage by diameter, moisture Retention, fat Retention, and thiobarbituric acid. The results showed an increase in the fiber content of meatballs prepared by increasing the addition of bran, a decrease in the concentration of cholesterol and thiobarbituric acid, the percentage of Thawing loss, the percentage of cooking loss, and the percentage of cooking shrinkage. Water-holding capacity, percentage of retained moisture, and retained fat also increased. The duration of storage also had a significant effect on the studied characteristics. The treatments to which rice bran was added obtained acceptable evaluation scores, close to the evaluation scores of the control treatment, especially the treatments to which 20% rice bran was added. Therefor. We recommend using rice bran in the manufacture of low-fat meat products, as it is rich in healthy dietary fiber and natural antioxidants and free of cholesterol.
Keywords: Chemical content, Meatballs, Qualitative characteristics, Rice bran

Introduction

There has been a growing interest in recent years to enhance the meat business by reinforcing meat products with dietary fibers. This fortification improves the quality and nutritional value of the goods, while also improving yields]19 [. Some meat products have been fortified with some plant sources rich in dietary fiber, such as wheat bran, rice bran, citrus peels, etc., as these products are good alternatives to meat due to their functional and nutritional properties. In addition, eating these products reduces harmful cholesterol and reduces the risk of nutritional problems such as obesity and nutritional disorders digestive system, intestinal infections, etc. Moreover, dietary fiber supplements increase the size of the product and prevent loss during cooking with changes in texture properties by enhancing the ability to bind water]16[. Dietary fiber is characterized by various functional properties, including solubility, viscosity, the ability to form gels, and the ability to bind water, which affects the quality and characteristics of the product. Due to these properties, dietary fiber has been included in the mixtures of many meat products, such as pies and sausages 2.] [
The manufacturing processes of many commodities, such as fruits and vegetables, generate significant amounts of plant waste. This waste is seen as a major contributor to environmental issues and therefore needs to be

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recycled and repurposed. Additionally, research has demonstrated that the peels of fruits and vegetables are rich in various minerals, organic acids, phenolic compounds, and other bioactive components. In addition, the peels are rich in sugars, flavonoids, carotenoids, folic acid, vitamin C, pectin, and essential oils, which offer significant advantages in both food production and human well-being]4 [. Fiber can improve the ability to hold water and retain fat and can act as stabilizers and emulsifiers, and on this basis it has been used as fat substitutes in processed meats. On the health side, regular consumption of dietary fiber helps reduce cholesterol, control glucose levels in the blood, improve digestion in the intestines, and stimulate the growth of beneficial bacteria [18,9,8,12.[

Utilizing plant waste can help alleviate food insecurity by harnessing the valuable and biologically active substances present in these wastes. By adding these wastes into meat products, the nutritional and functional characteristics of these products can be improved. Research has demonstrated that the inclusion of fruit and vegetable waste, in the form of extracts or powder, has had a notable effect. These waste products have improved the sensory characteristics and texture of the final product, while also extending its shelf life for consumption. The explanation is attributed to the elevated levels of dietary fiber and antioxidants. Utilizing plant secondary waste in the production of meat products offers a cost-effective solution for reducing food expenses. This serves as a compelling motivation for factory owners to engage in the utilization of secondary plant waste, while simultaneously guaranteeing the quality and safety of the resulting products]10 [. Rice bran (Oryza sativa) contains 50% carbohydrates, 20.85% fat, 13.35% protein, and 21% dietary fiber, 90% of which is insoluble fiber, including cellulose, hemicellulose, pectin, and B-glucan. As for soluble fiber, it is present in small levels and also contains mineral elements, especially potassium, phosphorus, magnesium, selenium and vitamins 15] [. The study aims to prepare low-fat meat ball by adding a vegetable source rich in fiber to improve its qualitative characteristics and monitor these characteristics during the storage period.

Materials and Methods

Raw Materials :

All raw materials used in the study, including meat, fat, table salt, spice mixture, black pepper, garlic, and frying oil, were purchased from local markets in Basra Governorate. Rice bran (Oryza sativa) was obtained from rice mills in Al-Mishkhab district in Al-Diwaniyah Governorate. It was cleaned and ground using the mill electric (Germany)at 28000 rpm, then sieved several times to obtain a fine powder saving in plastic boxes.

Preparation of Formula:

3kg of beef (thigh area) was chopped in an electric mincing machine with a diameter of 3 mm, and salt was added to it at a rate of 1.5% of the weight of the meat, and a mixture of meatball spices at a rate of 0.5%, for the meatball product mix, black pepper at a rate of 0.5%, and garlic at a rate of 0.25%, and fat was added to it at a rate of 10%. % and divided into four sections, 750 grams for each section.

Preparation of Treatments:

Four treatments were prepared, at a rate of (750) grams for each treatment, according to the rates of addition to rice bran: - The first treatment was no addition, the second treatment was the Addition of rice bran at a rate of 10%, the third treatment was the

addition of rice bran by 20%, the fourth treatment was the addition of rice bran by 30%. The meatballs were placed in a cork dish, covered in polyethylene bags, wrapped well, and stored in the freezer (-18 ± 2) for a period of 90 days, during which changes in the chemical content, chemical indicators, and physical characteristics were monitored during the storage periods of 0, 30, 60, and 90 days.

Determination of Crude Fiber :

The percentage of fiber was estimated according to the method mentioned in] 6 [with some modifications, by weighing 2 grams of plant waste used in the study and transferring it into a 500 ml conical flask and adding 200 ml of 1.25% sulfuric acid H2SO4, then heating it to Boiling temperature for 30 minutes, then cool it and filter it using a damp cloth, then wash the precipitate several times with distilled water and add 200 ml of 1.25% sodium hydroxide (NaOH), then heat it again to boiling for 30 minutes and then cool it and filter it using a cloth. Then wash the remaining material with 25 ml of ethyl alcohol, transfer it to a ceramic container and place it in a drying oven at a temperature of 135 degrees Celsius for an hour, then cool it, weigh it, pre-burn it, and transfer it to an incinerator at a temperature of 550 degrees Celsius for 2-3 hours. Then weigh them, then calculate the percentage of fiber using the following equation :

$$\textbf{Percentage of fiber} = \frac{\text{weight of the lid with the sample after drying - weight of the plate with the sample after incineration}}{\text{Sample weight}} * 100$$

Determination of Cholesterol

Cholesterol was estimated according to the method mentioned in the kit issued by the French company Biolab SA. 0.1 g of the samples, the control sample, and 1 ml of distilled water for the plank sample were taken and placed in test tubes. Then a mixture of R1 and R2 was added to the samples and 1 ml of R3 solution was added to the sample. The control and 1 ml of distilled water for the plank sample were then placed in a water bath at a temperature of 37°C for 10 minutes, then the absorbance was measured at a wavelength of 500 nm, then the cholesterol was calculated according to the following equation - :

$$\textbf{Cholesterol (mg/g)} = \frac{\textbf{reading of the absorbance of the sample}}{\textbf{Standard cholesterol absorbance reading}} * \textbf{Standard focus}$$

Physical Properties

Water Holding Capacity (WHC :(

The water carrying capacity of the prepared products was estimated according to the method presented in 5] [.10 g of meat was weighed, 20 ml of distilled water was added to it and mixed well with the sample. Then the contents were transferred to a cylinder with a funnel and filter paper at the end. The filtrate was received and its volume was recorded after 30 minutes, and the water carrying capacity was calculated as follows :

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Water Holding capacity (ml) = total amount of water (ml) – amount of water in the graduated cylinder (ml)

Thawing Loss:

The percentage of loss by dissolution was estimated according to the method mentioned in] 17[. This was done by weighing the frozen meatballs after removing the wrappers from them, then leaving these samples in the refrigerator (5 ± 1°C) for 24 hours. The balls were re-weighed after removing the liquids from the surface of the samples using filter paper, and the percentage of loss after thawing was calculated according to the following equation - :

$$\textbf{Thawing Loss} = \frac{\textbf{Weight of frozen meatballs (g) - Weight of meatballs after thawing (g)}}{\textbf{Weight of meatballs (g)}} \textbf{*100}$$

Cooking Loss :

The percentage of weight loss during cooking was estimated according to the method mentioned in]7[, by frying three pieces of each treatment in sunflower oil for five minutes on a hot plate, stirring until frying is complete. The percentage of weight loss was calculated according to the following equation - :

$$\textbf{Cooking Loss \%} = \frac{\textbf{Weight of meatballs before cooking (g) - Weight after cooking (g)}}{\textbf{Weight before cooking (g)}} \textbf{*100}$$

By calculating the weight loss during cooking, the percentage of the cooking yield was calculated according to the equation mentioned in]7.]

The method mentioned by]7[was followed to calculate the percentage of shrinkage by measuring the diameters of the products before and after cooking according to the following equation :

Cooking Shrinkage :

$$\textbf{Cooking Shrinkage \%} = \frac{\textbf{diameter of the meatballs before cooking - diameter of the meatballs after cooking}}{\textbf{Diameter of the meatballs before cooking}} \textbf{*100}$$

Moisture Retention :

The percentage of retained moisture was calculated according to the method mentioned in [11] and as the following equation :

$$\text{Moisture Retention \%} = \frac{\text{Weight of meatballs after cooking * moisture percentage in meatballs after cooking}}{\text{Weight of meatballs before cooking *moisture content of meatballs before cooking}} \text{*100}$$

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Fat Retention:

The percentage of retained fat was calculated according to the method mentioned in]11[by calculating the percentage of fat in the products before and after cooking, from which the percentage of retained fat was calculated according to the following equation -:

$$\textbf{Fat Retention \%} = \frac{\textbf{Weight of meatballs after cooking * Fat percentage in meatballs after cooking}}{\textbf{Weight of meatballs before cooking * Fat content of meatballs before cooking}} * \mathbf{100}$$

Thiobarbituric Acid (TBA:(

The method by]14[was followed by mixing 20 g of the sample with 100 ml of Trichloroacetic acid solution and mixing it well with a magnetic stirrer for two minutes, then filtering the homogeneous mixture using filter paper and adding 5 ml of TBA reagent (0.02) m to 5 ml of The filtrate was carefully measured in a test tube. The tube was placed in a water bath for 40 minutes, then the absorbance of the resulting color was measured using a spectrophotometer at a wavelength of 538 nm, and the TBA values were calculated according to the following equation :

$$\boldsymbol{TBA} = \frac{\mathbf{0.016 + 2.782}}{\mathbf{10}} - \boldsymbol{X\ mg\ /\ 100g}$$

X = absorbance of the sample at 538 nm

Results and discussion

Effect of bran addition percentage on the prcentage of dietary fiber in meatballs

The results in Figure (1) showed an increase in the percentage of dietary fiber in meatballs to which rice bran was added, reaching 10.83%, 14.51%, and 18.82% at addition rates of 10%, 20%, and 30%, respectively. These results agreed with]17[in their study on the effect of adding different levels of date seed powder on the quality characteristics of beef meatball. They found that the percentage of dietary fiber increased significantly when adding date seed powder at levels of 4%, 8%, 12%, and 16%. The percentage of dietary fiber increased in the treatments to which date seed powder was added in the above proportions to 2.88%, 4.75%, and 6.22%,7.93%, respectively. In comparison, its percentage in the control treatment was 1.21%

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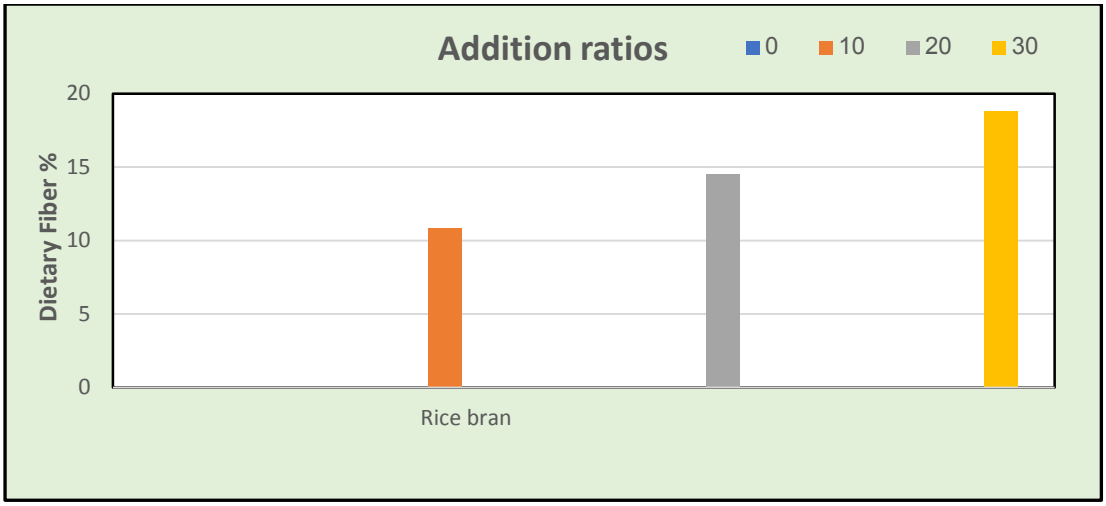

Figure (1): Shows the effect of the addition rate on the percentage of dietary fiber in meatballs R.L.S.D. 3.520

Effect of bran addition percentage on the percentage of Cholesterol in meatballs

The results in Figure (2) show a decrease in cholesterol concentration with increasing addition rates. This decrease in cholesterol content was proportional to the increase in rice bran level because rice bran is free of cholesterol. The cholesterol concentration in meatballs to which rice bran was added decreased from 68.96 mg/100 g in the control treatment to 64.57, 61.86, and 57.43 mg/100 g at 10% and 20% addition rates. and 30%, respectively.

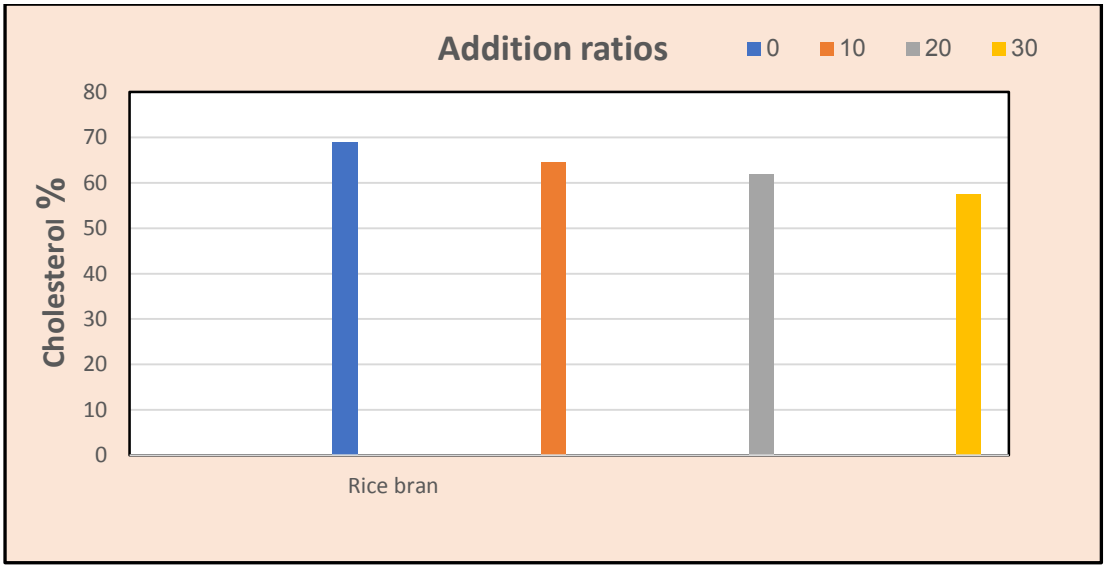

Figure (2) shows the effect of the addition ratio on the cholesterol concentration in meatballs R.L.S.D. 2.710

Effect of bran addition percentage on the percentage of Fat in meatballs

The results in Figure (3) show a significant increase ($P<0.05$) in the percentage of fat in meatballs to which rice bran was added, as it rose from 11.17% in the control treatment to

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12.12%, 13.82%, and 14.47% at the addition rates of 10% and 20%. % and 30%, respectively

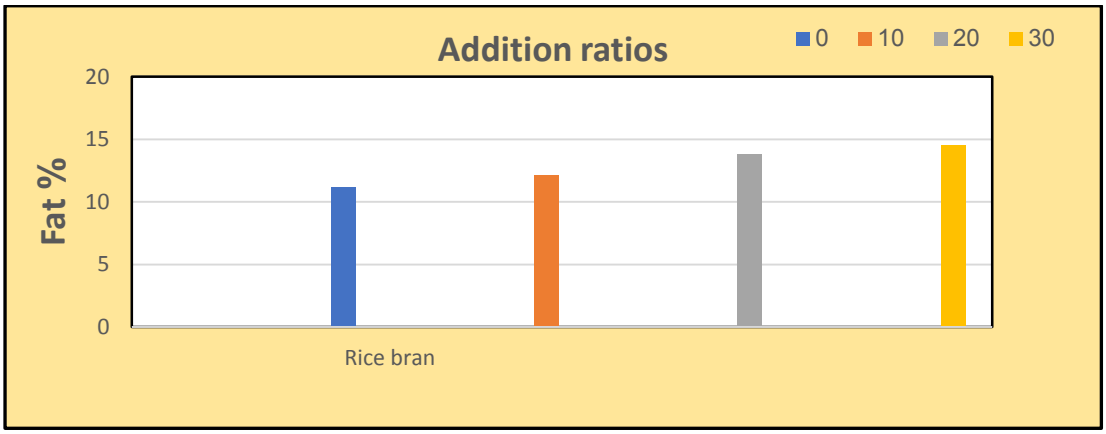

Figure (3) shows the effect of the addition ratio on the Fat percentage in meatballs R.L.S.D. 0.075

Effect of the addition rate and storage period on water holding capacity

The data presented in Figure (4) indicate a significant augmentation in the water-holding capacity of the treatments that incorporated rice bran, as compared to the control treatment. An augmentation in the water-holding capacity was likewise noted with escalating addition rates, as the water-holding capacity progressively rose in the meat balls that had rice bran incorporated, reaching 14.77 ml in the treatment. The control volume grew to 16.76 ml after adding 10%, then to 18.53 ml and 19.76 ml when the percentages were raised to 20% and 30%, respectively. The findings were consistent with the research conducted by] 1 [on the impact of incorporating date pit powder at different concentrations (4%, 8%, 12%, and 16%) on certain qualitative attributes of beef meatballs. Specifically, they observed a significant enhancement in the water-holding capacity of the meatballs. The water-holding capacity increased from 1.29 in the control group to 3.06, 4.49, 6.49, and 8.14 in the groups where the powder was added at the aforementioned concentrations, respectively. The explanation for this rise was related to the high fiber content in the date pit powder, which reached 35.24%. This high fiber content resulted in an increase in the water-carrying capacity of the cooked meatballs compared to the control treatment, as it decreased. The water holding capacity of the meatballs rose during the storage time in all treatments, particularly notably in the control treatment from 14.77 ml before storage to 14.46 ml at the conclusion of the 90-day frozen storage period. Regarding the treatments that included the addition of 10% rice bran, there was an increase. The water carrying capacity exhibited a decline from 16.76 ml before to storage to 16.66 ml after a storage period of 30 days. Subsequently, it further reduced to 16.51 ml and 15.42 ml after 60 and 90 days, respectively. The loss in water retention ability is caused by the heightened degradation of beef tissue cells during freezing, resulting in the release of a significant amount of released liquid during the thawing and cooking process] 2 .]

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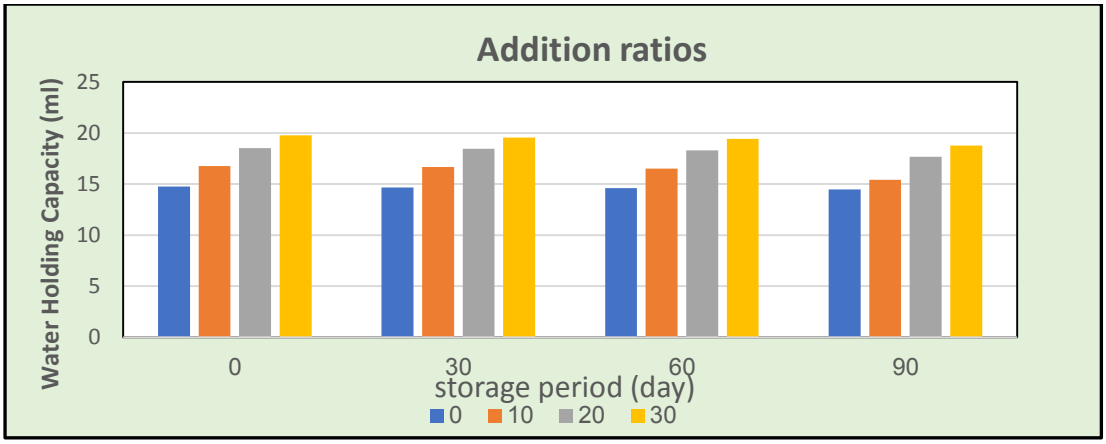

Figure (4): Effect of the addition rate and storage duration on the water-holding capacity of R.L.S.D. 1.190

Effect of the addition rate and storage duration on the percentage of thawing loss during defrosting

The data presented in Figure (5) demonstrates a statistically significant reduction (P<0.05) in the proportion of weight loss observed in meatballs that were supplemented with rice bran, as compared to the control group. The addition had a significant effect (P<0.05) on the percentage of weight loss after thawing, resulting in a decrease in the percentage of loss. The inclusion of rice bran powder in meatballs resulted in a gradual decrease in the percentage of addition, from 6.48% in the control treatment to 5.83%, 5.28%, and 4.78% when adding 10%, 20%, and 30%, respectively. The percentage of weight loss during thawing exhibited a substantial rise, which was statistically significant (P<0.05). In the control treatment, the time of storage caused an increase in percentage from 6.48% before storage to 10.03% after 90 days of freeze storage. The addition of 30% rice bran to the meatballs resulted in an increase in its content from 4.78% to 0.736% after a freeze storage period of 90 days. This is a result of the rise in the storage period continues, the rate of loss through defrosting increases because of the significant size of the ice crystals formed during freezing. These ice crystals are lost as water droplets during the defrosting process, resulting in an increase in the amount of extracted liquid [[3

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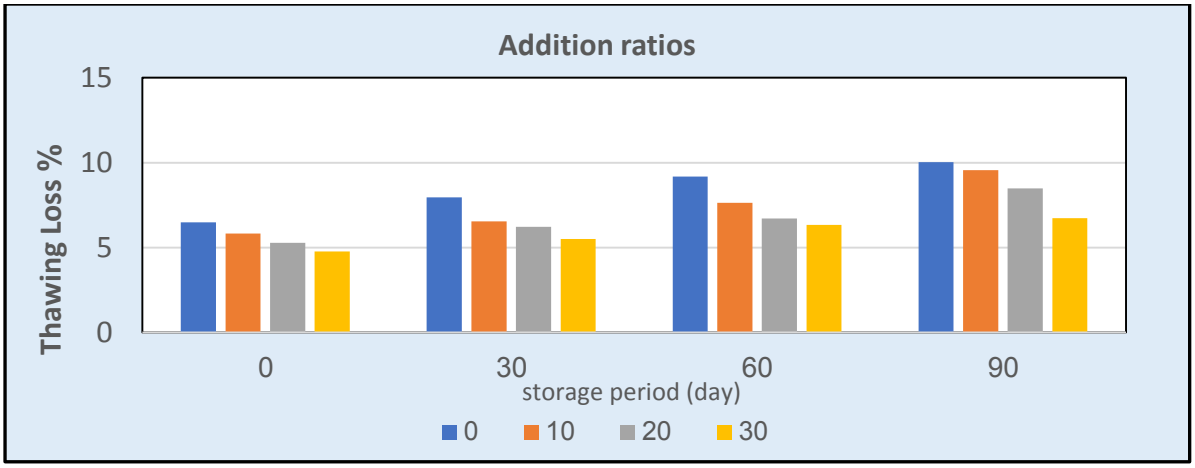

Figure (5): Effect of the addition rate and storage duration on the percentage of thawing loss in meatballs R.L.S.D. 0.857

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Effect of the addition rate and storage duration on the percentage of cooking loss.

The results in Figure (6) showed a decrease in the percentage of loss during cooking in meatballs to which rice bran was added from 28.88% in the control treatment to 21.82%, 15.77%, and 10.12% when the addition percentage was increased to 10%, 20%, and 30%, respectively. These results agreed with [13] studied the effect of adding 2.5% of corn starch, 2.5% of quinoa starch, 10% of quinoa seeds, (10:2.5)% of corn starch and quinoa seeds, and (10:(2.5%) of quinoa starch and seeds quinoa on the percentage of weight loss during cooking of chicken meatballs. They noticed that adding a mixture of cornstarch and quinoa seeds and a mixture of quinoa starch and quinoa seeds in the ratios (10:2.5)% to the treatments led to a noticeable decrease in the percentage of weight loss during cooking compared to the treatments of corn starch, quinoa starch, and quinoa seeds were added at levels of 2.5%, 2.5%, and 10%, respectively, the percentage of weight loss decreased from 15.30%, 15.35%, and 25.87% for the treatments to which corn starch, quinoa starch, and quinoa seeds were added at the above levels, respectively, to 14.03% and 13.86% for the treatments to which a mixture of cornstarch and quinoa seeds and a mixture of quinoa starch and quinoa seeds were added in proportions (10:2.5%), respectively. It was also noted from the results of the statistical analysis that there was a significant increase ($P<0.05$) in the percentage of weight loss during cooking as the storage period progressed. The increase in the percentage of loss during cooking was higher after 90 days of freeze storage, as it reached 30.95% in the control treatment, while the percentage of loss was during cooking, the percentage of meatballs to which rice bran was added was lower, as it reached 24.75%, 18.67%, and 15.64% at the addition rates of 10%, 20%, and 30%, respectively, and after 90 days of freeze storage

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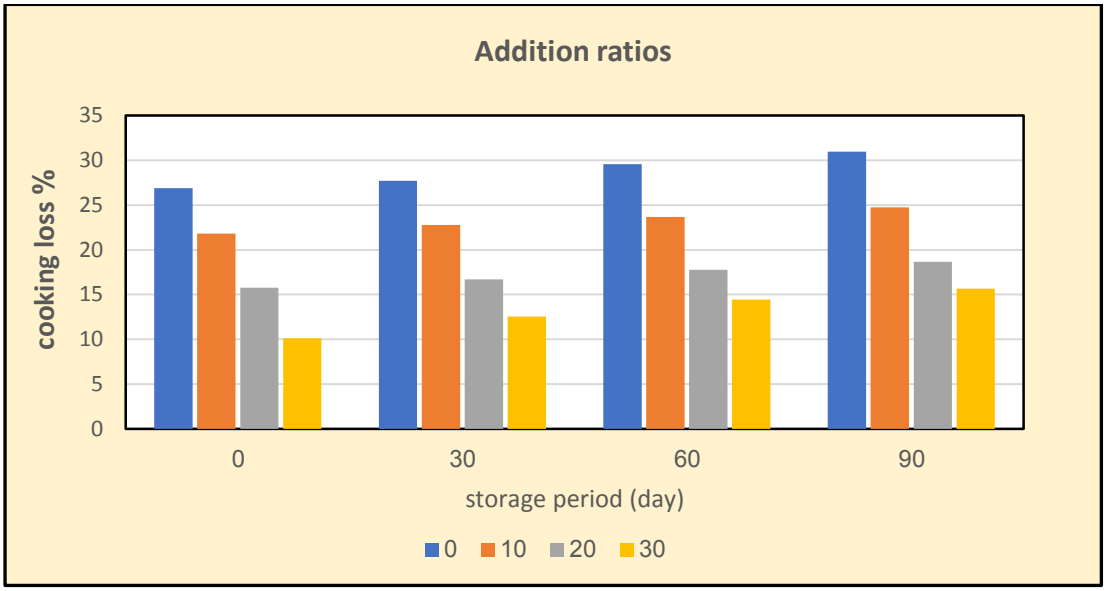

Figure (6): The effect of the addition rate and storage duration on the percentage of weight loss during cooking in meatballs R.L.S.D. 1.180

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Effect of the addition rate and storage period on shrinkage diameter

The data presented in Figure (7) demonstrates a statistically significant reduction (P<0.05) in the rate of diameter shrinkage in the meatball product when rice bran was included. The shrinkage rate reduced from 15.68% in the control group to 13.48%, 11.68%, and 10.44% when 10%, 20%, and 30% of rice bran was added, respectively. The findings indicated a notable rise in the percentage of diameter shrinkage (P<0.05) with an increase in the duration of storage. In the control treatment, the shrinkage rose from 15.68% before to storage to 18.71% after 90 days of freeze storage. The meatballs, which had rice bran added at a rate of 20%, had an initial moisture content of 11.68%. After 30, 60, and 90 days of freeze storage, the moisture content increased to 12.51%, 15.55%, and 16.87%, respectively

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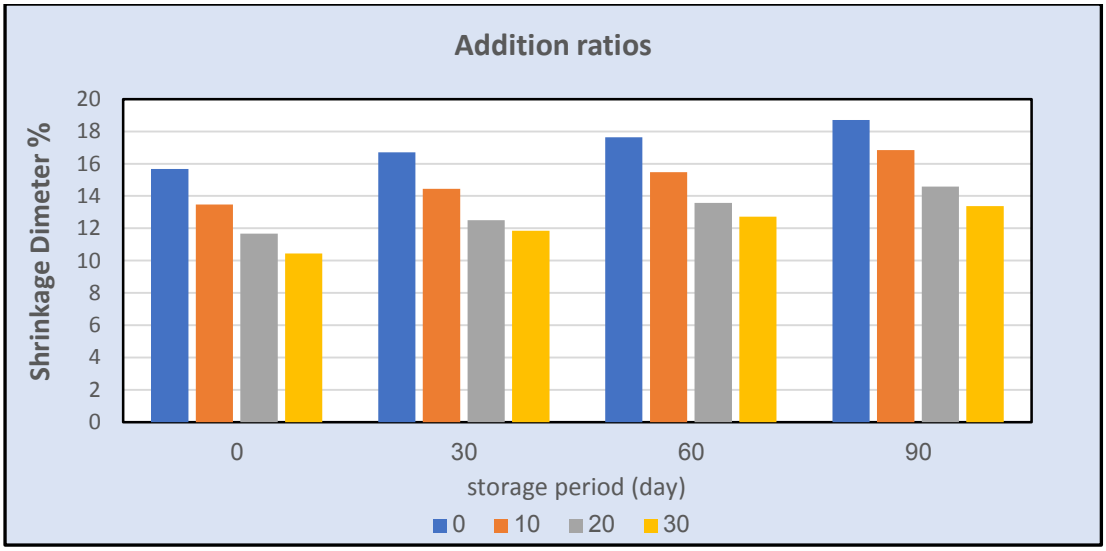

Figure (7): Effect of the addition rate and storage duration on the diameter shrinkage rate in R.L.S.D. 0.976

Effect of the addition rate and storage period on the percentage of moisture retention

The data presented in Figure (8) clearly indicate a substantial increase in the moisture retention of the meatballs across all treatments where rice bran was used, as compared to the control treatment. The percentage of retained moisture in the control treatment was 62.88%. When 10% of rice bran powder was added, it increased to 65.83%. With further increases in the addition rates to 20% and 30%, the percentage of kept moisture increased to 67.54% and 69.57%, respectively. The results were consistent with the findings of]1[who investigated the impact of incorporating date pit powder at concentrations of 4%, 8%, 12%, and 16% on the qualitative attributes of beef meatballs. An observed rise in the percentage of retained moisture was noted, with the control treatment showing a percentage of 18.58% and the subsequent levels showing percentages of 22.00%, 25.79%, 29.75%, and 33.64% respectively. These percentages represent the amount of moisture retained in the

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meatballs during storage. The percentage of moisture preserved exhibited a slow and considerable decline throughout the course of the storage time. The control treatment exhibited a reduction from an initial value of 62.88% to a final value of 57.78% during storage. The treatments containing 20% rice bran experienced a drop to 64.58% after 90 days of successive freeze storage.

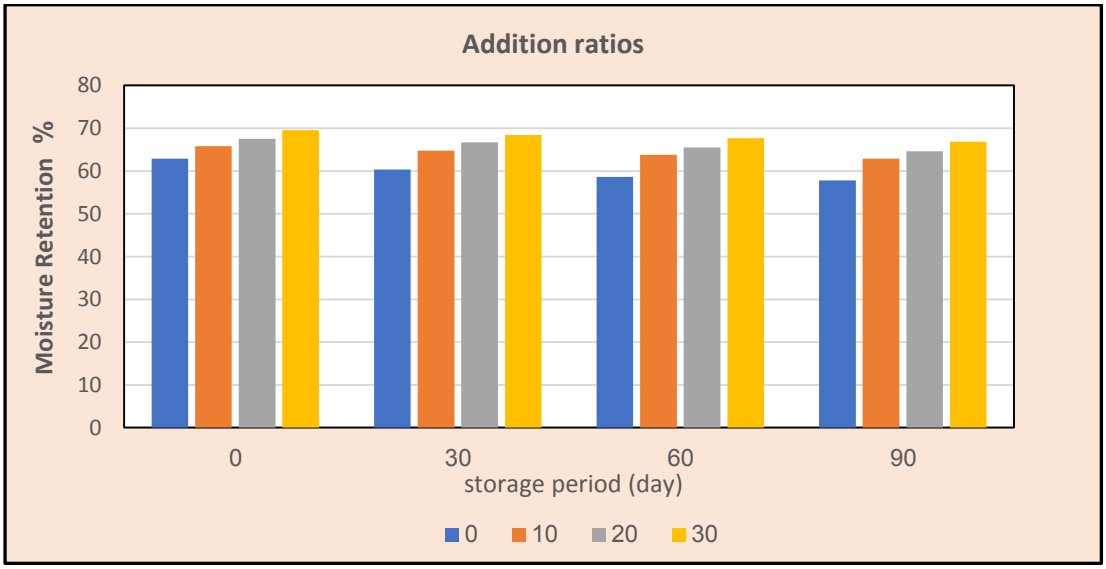

Figure (8): Effect of the addition rate and storage duration on the percentage of moisture retained in R.L.S.D. 0.931

Effect of the addition rate and storage duration on the percentage of fat retention

The results of the statistical analysis in Figure (9) showed a significant increase in the percentage of retained fat ($P<0.05$) in all treatments to which rice bran was added compared to the control treatment. It was noted that the percentage of retained fat increased with the increase in the addition rate. It increased in the treatments from 66.92% when adding 10% to 69.93% and 72.63% when adding 20% and 30%, respectively. The percentage of fat retained in the meatballs was significantly affected ($P<0.05$) by the duration of storage, as it decreased in the control treatment from 63.78% before storage to 61.66%, 59.46%, and 58.16% during periods of 30, 60, and 90 days of freeze storage, respectively. While in the balls added 10% of rice bran, it decreased from 66.92% before storage to 64.72%, 63.56% and 62.66%, respectively

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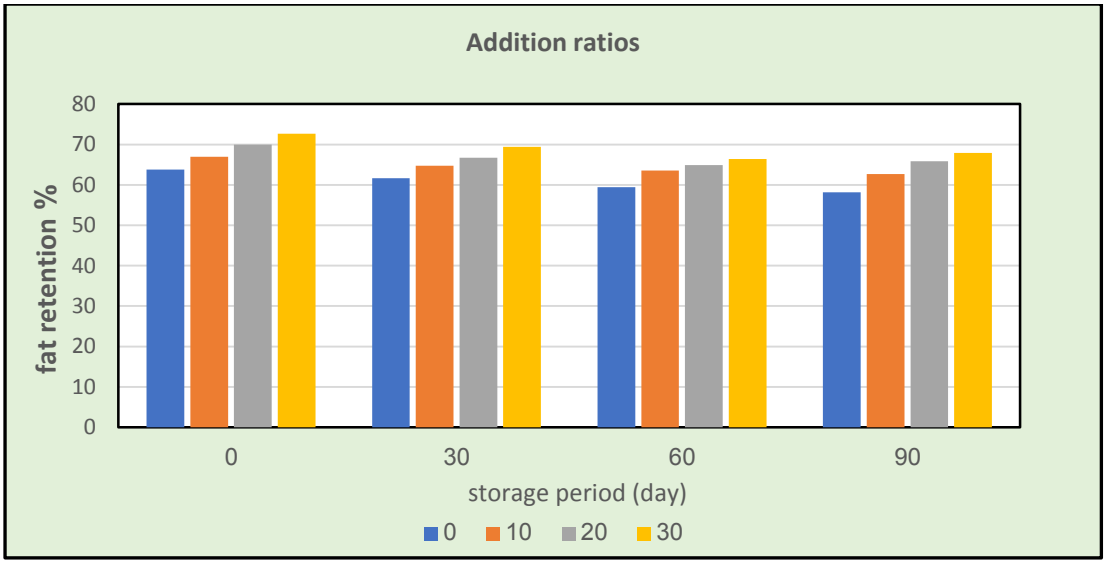

Figure (9): Effect of the addition rate and storage duration on the percentage of fat retained in R.L.S.D. 0.531

Effect of fiber source, addition rate, and storage duration on the percentage of thiobarbituric acid

The data presented in Figure (10) indicate a significant decrease ($P<0.05$) in the concentration of thiobarbituric acid when rice bran was added to the meatballs, as compared to the control treatment. The concentration of malonaldehyde fell from 0.46 mg/kg when adding 10% to 0.34 and 0.28 mg/kg when increasing the addition rate to 20% and 30% respectively. The findings of this study align with the results reported by]18[in their investigation on the impact of incorporating insoluble dietary fiber from kiwi offal on the thiobarbituric acid levels in pork meatballs. It was observed that the addition of dietary fiber at different levels (0.5%, 1.0%, 3.0%, 5.0%, and 7.0%) resulted in a considerable reduction in acid values. As the amount of dietary fiber decreased, the acid values declined from 0.92 mg malonaldehyde/kg in the control treatment to 0.37 The amounts of malonaldehyde were 0.31, 0.22, 0.17, and 0.13 mg/kg for the mentioned values, respectively. The decrease in TBA values was linked to the reduction in dietary fiber's fat percentage, resulting in a fall in unsaturated fatty acids concentration and subsequently reducing fat oxidation in the product. The acid value exhibited a substantial increase ($P<0.05$) with the progression of the storage period. In the control treatment, the level of malonaldehyde grew from 0.48 mg/kg before storage to 2.53 mg/kg after 90 days of freeze storage. In the meatballs with added rice bran, the levels of malonaldehyde increased to 0.46 mg/kg, 0.34 mg/kg, and 0.28 mg/kg when 10%, 20%, and 30% of rice bran were added, respectively, before storage. The levels of malonaldehyde in storage reached 2.42, 2.02, and 1.88 mg/kg after 90 days of frozen storage

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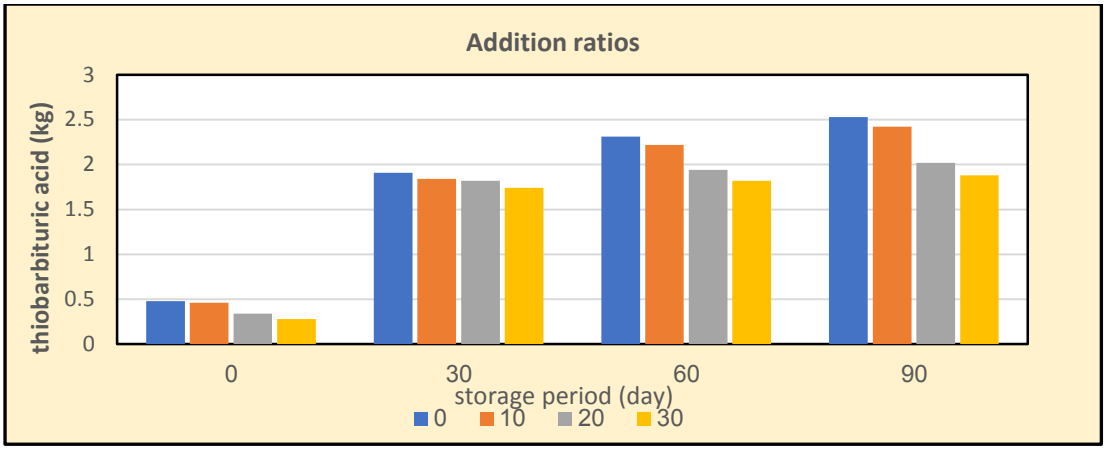

Figure (10): Effect of addition rate, and storage duration on the percentage of thiobarbituric acid in R.L.S.D. 0.135

Conclusion

We conclude from this study that the physical, chemical and sensory properties can be improved by adding rice bran. The treatment to which 20% was added obtained the best scores for sensory evaluation, in addition to an increase in water holding capacity and a reduction in the oxidation process as a result of rice bran containing active compounds that have a high potential as antioxidants. This was demonstrated by the values of TBA , which were low compared to the control treatment.

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