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Benefits evaluation of quinoa flour powder instead of animal fat on quality of beef and chicken burgers

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Abstract

The research aims to determine how to improve the production of beef and chicken burgers by partially substituting animal fat with quinoa flour, through a study that covered all of the chemical, physical, and sensory characteristics of hamburgers. A 35% quinoa powder fat substitute was used to make beef and chicken burgers. The data suggests that: 1 quinoa flour produces beef and chicken burgers with higher moisture and protein levels than the control group; 2 both treatments have produced lower total fat than the control group; 3 the two treatments both increase the water-holding capacity of the beef and chicken burger, and reduce the amount of cooking weight loss; thus improving the quality of the product; 4 all of the technological attributes of the product showed a consistent and significant increase. Therefore, due to the significant increase in the product's nutritional and technological efficiency, quinoa flour can be considered a viable partial replacement for animal fats in the beef and chicken burger market.

Keywords: Quinoa flour, chicken burger, chemical properties, water holding capacity

Introduction

Today, consumers are becoming more aware of the importance of consuming healthy and nutritious foods as food fulfills two functions: to satiate hunger and to ensure the maintenance of physical health. Many consumers are now making better choices and consuming less fat as part of a growing trend toward consuming healthy foods that provide the body with adequate nutrition and increase the immune system's ability to fight disease [1]. Grains are one of the best examples of foods that induce health, reduce disease risk, provide a high level of nutrition, and are very easily reformulated [2].

One of the primary sources of fat in a person's diet is meat. Meat has high levels of saturated fat, saturated fatty acids, and cholesterol, which contribute to a variety of health-related diseases, such as cancer, obesity, and heart disease. The first step to preventing each of these diseases is to reduce the consumption of saturated fat in the diet [3].

In recent times, global interest has increased in the mechanisms of partial replacement of some components of burgers, especially fats, by using some plant materials, as they are considered binding and filling materials that aim to improve the nutritional, health, and sensory qualities and reduce the cost of the final product [4]. However, the challenge facing food technologists is to preserve the nutritional, sensory, chemical, and physical properties of the product [5].

Quinoa (*Chenopodium quinoa* Wild) is a gluten-free pseudo-grain, which contains both macro and micronutrients. The nutrient content of quinoa is high in both fibre and protein (at least 25 percent of total calories) and contains fats made largely of ω -3 and ω -6 fatty acids [6].

Due to the many nutritional benefits provided by quinoa, it has become one of the most popular cereals in the world. The grain contains significant amounts of dietary fibre, minerals, and vitamins. Unlike wheat grains, quinoa does not contain gluten and has higher amounts of the amino acids lysine and methionine [7].

Another alternative to making functional foods is to replace traditional food ingredients with quinoa. The powdered form of this grain has already been utilized in the manufacture of many food products, including baked goods, baby food, chips, and beer; however, limited research is available on using powdered quinoa in meat or meat-based products such as burgers [8]. Beef burgers are some of the most commonly eaten meat products, and they are an ideal choice for quick and easy meals [9].

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In traditional burgers, quinoa is used instead of animal fat [10]. Therefore, the purpose of this study was to evaluate the effects of quinoa seed flour powder as a partial substitute for fat on the chemical, physical, and sensory properties of beef and chicken patties.

Materials and Methods

Materials utilized in this investigative experiment were procured at the food store of Mr. Ghassan Al-Zaytoun of

Tikrit, Iraq (beef thigh, chicken, and lamb meat, and quinoa). All of the items were stored in the refrigerator at a temperature of 4 degrees Celsius. The meat items were cut into small pieces, while the beef and the lean chicken were then minced with an electric mincer. The minced lamb meat was processed separately from the other meat, then frozen until mixed. Patty preparation included measuring 50 g each as indicated in Table (1).

Table 1: Proportions of ingredients used in preparing the beef and chicken burger mixture

Treatment	Veal and chicken gr	Fat gr	Quinoa powder Gr	Garlic%	Salt%	Spices%
No-added beef burger	800	200	---	0.25	1.5	0.5
Beef burger with 35% fat replaced with quinoa	800	65	35	0.25	1.5	0.5
No-added chicken burger	800	200	---	0.25	1.5	0.5
Chicken burger with 35% fat replaced with quinoa	800	65	35	0.25	1.5	0.5

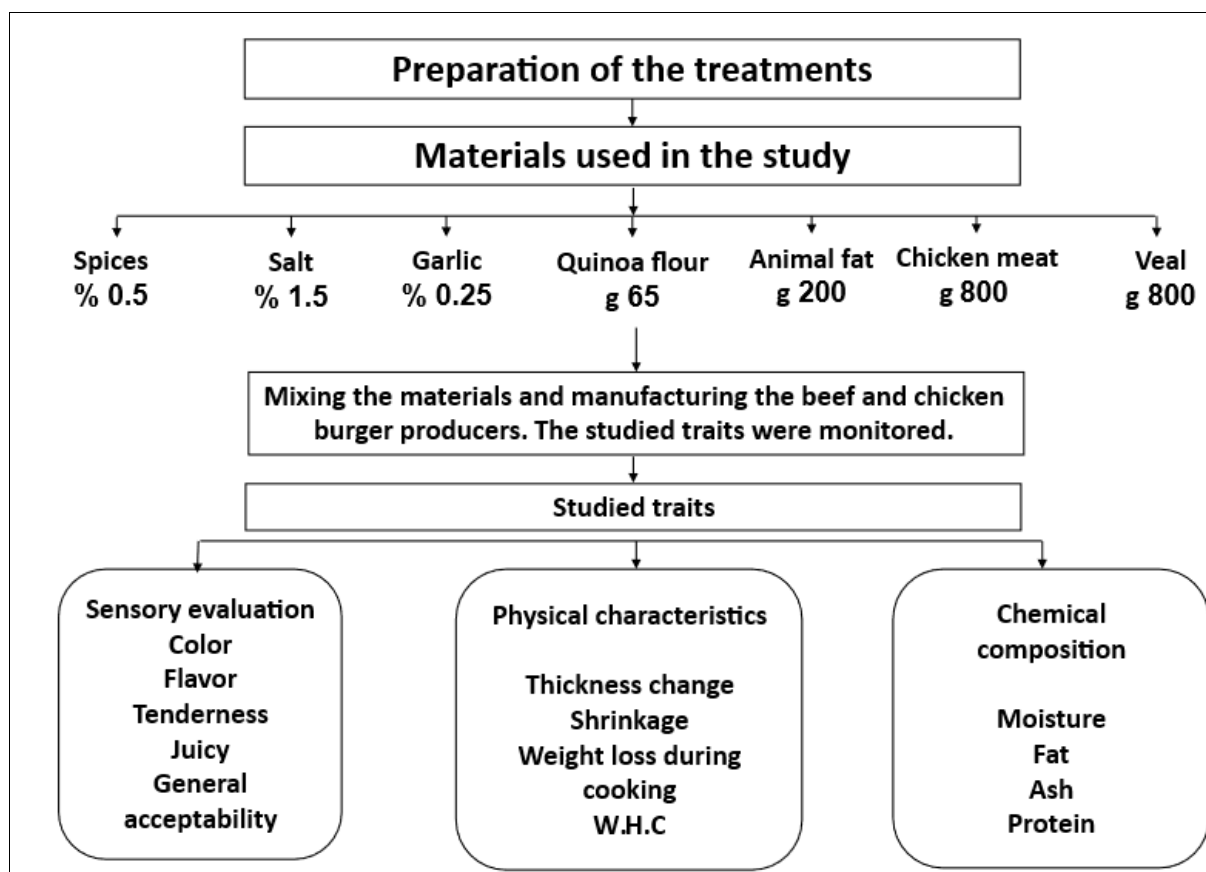


Fig 1: A diagram illustrating the standards measured in the experiment of replacing animal fats with quinoa flour powder for veal and chicken burger producers

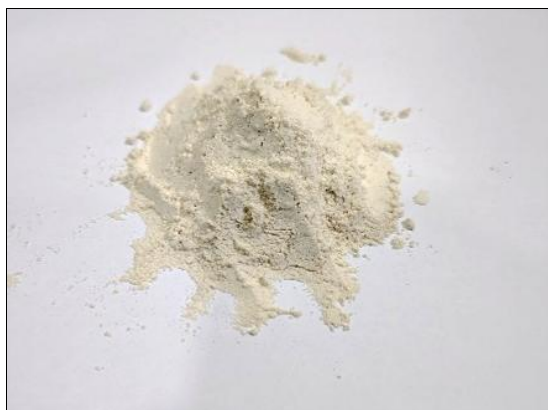


Fig 2: Shows the quinoa flour used in the research

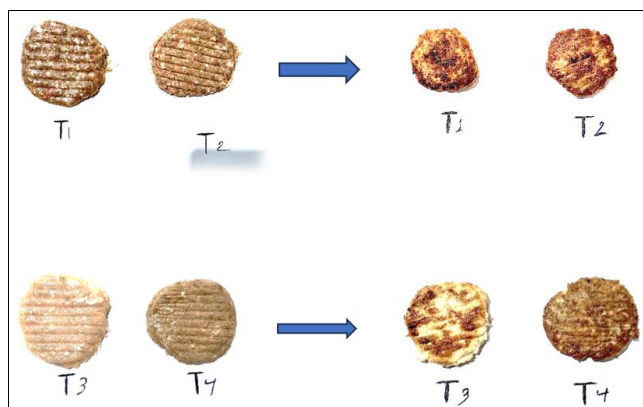


Fig 3: Shows the burger discs used in the study

Chemical composition

Estimation of the chemical compositions of the burger examples in this study followed the AOAC ^[11], method. Moisture in each of the burger examples was determined by weighing loss through moisture evaporation. Proteins were determined using the KJELDAHL method, and fats were estimated using a SOXHLET apparatus. Ash content of each burger example was estimated by incinerating (in a pre-weighed porcelain dish) each sample of dry hamburger in an incinerator operating at 525 °C for 6 hours.

Physical tests

The change in thickness was measured according to method

^[12], The shrinkage in diameter and the percentage of weight loss during cooking were estimated according to the method ^[13]. The water retention capacity was calculated according to the method ^[14].

Sensory Evaluation

The manufactured samples were evaluated via a panel of faculty members and graduate students who possess sufficient experience for sensory evaluation of the product. The sample evaluation was based upon the factors of color, tenderness, flavor, juiciness, and overall acceptability and was conducted in accordance with the method referenced by ^[15].

Samples	Color	Flavor	Texture	Juiciness	Overall Acceptability	Comments
T ₁						
T ₂						
T ₃						
T ₄						

								
I don't like it very much	I don't like it very much	I don't like it to some extent	I don't like it a little	I didn't like it, but I didn't dislike it either	I liked it a little	I liked it to some extent	I liked it a lot	I liked it very much

Fig 4: Sensory evaluation score form for burger discs ^[16]

Statistical analysis

Statistical analysis was derived from the data collected through a completely randomized design (CRD). A minimum level of significance (P) for comparison of the means was conducted using Duncan's Test ($P \leq 0.05$) ^[17] and analyzed utilizing SAS statistical software (2010) ^[18] according to the following statistical model:

$$Y_{ij} = \mu + T_i + e_{ij}$$

Results and Discussion

Chemical composition

Table No. (2) illustrates how the utilization of quinoa flour powder as a partial replacement for animal fats has altered the chemical composition of beef and chicken burger preparations. Moisture percentages were highest in T₂ and T₄ preparations, 67.7% and 66.71%- lowest in T₁ and T₃ preparations, 65.49% and 65.03%. The increased moisture content in T₂ and T₄ is likely due to the properties of the

filling material, which perform primarily as a medium to absorb and retain water; Therefore, studies conducted by ^[19, 20] have similar findings.

Fat content reduction of T₂ and T₄ were 13.04% and 14.31%, respectively; T₃ and T₁ increased fat content (17.4%, 16.28%, respectively). Fat content was decreased due to the replacement of saturated fat from animal sources with low-fat from a plant source-Critical! - quinoa flour powder. Similar findings to ^[21, 22] were determined.

The table also shows that there was a large increase in both protein content and total ash in T₂ and T₄ (16.06% and 16.16% for protein, 1.78% and 1.76% for total ash) but a large reduction in both of these factors for T₁ and T₃ (15.46% and 15.16% for protein, 1.24% and 1.18% for total ash). The high ash values found in both T₂ and T₄ replacement tests are indicative of the presence of minerals in quinoa, such as calcium, zinc, iron, and magnesium, where the ash content in the results is nearly identical to ^[23, 24].

Table 2: Changes in the chemical properties of veal and chicken burgers

Traits Treatments	Moisture	Fat	Ash	Protein
T ₁	65.03±0.01c	17.4±0.9a	1.24±0.01b	15.16±0.7b
T ₂	67.7±0.24a	13.04±0.3b	1.78±0.01a	16.06±0.01a
T ₃	65.49±0.01c	16.28±0.27a	1.18±0.1c	15.46±0.4b
T ₄	66.71±0.19b	14.31±0.41b	1.76±0.01a	16.16±0.01ab
Significantly	*		*	N.S

* Different letters in the same column show a significant difference using Duncan's test ($P \leq 0.05$)

T₁: Beef burger without additives, T₂: Beef burger with 35% fat replacement with quinoa, T₃: Chicken burger without additives, T₄: Chicken burger with 35% fat replacement with quinoa

Physical traits

The percentage changes in thickness when cooking beef and chicken burgers are shown in Table 3. T₄ and T₂ substitutions had the highest percent change in thickness from cooking (19.21% and 14.53%). T₃ and T₁ had lower percent changes in thickness from cooking (7.93% and 10.94%, respectively). The increase in the percent change in thickness from cooking in T₂ and T₄ can be attributed to quinoa flour containing fibrous structures, which allow it to retain both water and air when cooking. These results agree with [25, 26].

Meanwhile, it was observed that the diameter shrinkage rate of beef and chicken burgers with fat substituted with quinoa powder decreased from 34.55% in treatment T₁ to 28.62% in treatment T₂, and to 15.16% in treatment T₄. The decline in the deflation rate in exchange transactions can be explained by the release of fat, water, and meat protein during cooking, in addition to the fact that the expanding

agents used in the burger mixture can form a gel and retain a certain amount of moisture and fat, which limits shrinkage in beef and chicken burgers. This is consistent with [27, 28].

The results in Table (3) show that the percentage of weight loss during cooking has a significant effect ($P < 0.05$) on plant fibers. It is noticed that there is a decrease in the percentage of weight loss during cooking in the two treatments (T₄ and T₂), 12.29% and 29.69%, respectively. But, in the treatments (T₃, T₁) it was recorded 34.23% and 18.81%, respectively. This may be due to the ability of quinoa to absorb water and prevent its loss during heat treatment. The results are close to [29, 30].

Finally, water holding capacity increased significantly in T₄ as it was able to retain 66.12% water compared to T₁, which was able to retain 49.49% water. Increased water retention capacity is because the quinoa flour in both replacements binds with water and has a very high absorption capacity. These results are similar to [31, 32].

Table 3: Changes in the physical properties of beef veal and chicken burger meat

Traits Treatments	Change in thicknes due to cooking	Shrinkage	Weight loss during cooking	W.H.C
T ₁	7.93±0.02d	34.55±0.02a	34.23±0.12a	49.49±0.03a
T ₂	14.53±0.01b	28.62±0.1b	29.69±0.03b	62.59±0.02b
T ₃	10.94±0.2c	26.65±0.03c	18.81±0.2c	59.91±0.02c
T ₄	19.21±0.1a	15.16±0.01d	12.29±0.12d	66.12±0.02a
Significantly	*	*	*	

* Different alphabets in the same column show significant difference using Duncan's test ($P \leq 0.05$)

T₁: Beef burger without additives, T₂: Beef burger with 35% fat replacement with quinoa, T₃: Chicken burger without additives, T₄: Chicken burger with 35% fat replacement with quinoa

Sensory analysis

Data in Table (4) indicate how using a plant-based additive affects color ratings of beef and chicken burgers. There were no statistically significant differences ($P \leq 0.05$) between color ratings among any of the groups of burgers examined. The reason for this finding might be that the colors of the meat products are determined by the pigments present in the meat, and plant-based additives have no effect on those pigments [33, 34].

In contrast, flavor ratings were statistically different between the treatments evaluated. Treatments T₄ and T₂ have the lowest mean flavor ratings, 7.1 and 7.1, respectively, while treatments T₁ and T₃ had the highest mean flavor ratings, 8.1 and 7.7, respectively. The relatively low flavor ratings for the plants containing quinoa in T₄ and T₂ may be due to the taste associated with quinoa that might not match up to consumers' expectations of a traditional hamburger flavor [35].

On the other hand, the softness rating increased

significantly in treatments T₄ and T₂ to 8.3 and 7.8, respectively, while decreasing in treatments T₃ and T₁ to 7.6 and 7.3. The reason for the high softness rating is attributed to the increased water-holding capacity in quinoa powder, as it is a filler material that holds the largest amount of water. The results were close to [36, 37].

Also, the addition of quinoa flour powder resulted in a higher mean juiciness score, for T₂ 8.4, followed by T₄ 7.9, than T₁ 7.2 or T₃ 7.2. The justification for the higher juiciness ratings for T₂ and T₄ might relate to their being effective fillers that retain moisture [38].

Meanwhile, the highest overall acceptability rating was recorded in treatments (T₁ and T₃), 7.3 and 7.2, respectively. Whereas, it decreased in treatments (T₂ and T₄), 6.1 and 6.2, respectively. The reason for the lower overall acceptability rating in the quinoa flour powder treatments is attributed to the lower rating of the flavor rating. The results were close to [39, 40].

Table 4: Changes in the sensory properties of beef and chicken burger meat

Traits Treatments	Color	Flavor	Tenderness	Juicy	General Acceptability
T ₁	8.2±0.2a	8.1±0.29a	7.6±0.1b	7.2±0.3b	7.3±0.3a
T ₂	8.1±0.2a	7.1±0.3b	8.3±0.2a	8.4±0.1a	6.1±0.2b
T ₃	7.7±0.1a	7.7±0.1a b	7.3±0.1b	7.2±0.2b	7.2±0.1a
T ₄	7.5±0.2a	7.1±0.2b	7.8±0.4a b	7.9±0.2a b	6.2±0.2b
Significantly	*	*	*	*	

* Different alphabets in the same column show significant difference using Duncan's test ($P \leq 0.05$)

T₁: Beef burger without additives, T₂: Beef burger with 35% fat replacement with quinoa, T₃: Chicken burger without additives, T₄: Chicken burger with 35% fat replacement with quinoa

Conclusion

According to the study's findings, quinoa may be a successful partial-fat substitute in burger products to

improve their nutritional content. Quinoa flour can replace 35% of animal fat in the process of producing beef and chicken hamburgers and provide significant improvements

in the chemical and physical properties of the final product and in some sensory properties. There was an increase in moisture and protein, which gives a greater nutritional value. Furthermore, the reduction of the fat content improves the health of a hamburger and promotes healthy eating. The improvement of the water retention and reduced cooking loss, as evidenced by improved chemical and physical properties of the product, indicates improved cooking performance and tenderness of the finished product. In terms of sensory assessment of the product, it demonstrates that the product is tender and juicy, which is highly beneficial for preserving the quality of the final product. Overall, the data demonstrate that the use of quinoa flour can be used as a viable nutritional and functional ingredient to add to the technological/nutritional properties of processed meats while maintaining product quality.

Recommendations

It is recommended that quinoa be utilized as a healthy fat alternative. The proportion of quinoa that should be used will vary depending on whether you are attempting to obtain the optimum nutritional value or the optimum sensory qualities. Various spices or methods of preparing quinoa may be used to improve its overall taste and make it more attractive; this is also true for other foods prepared from quinoa. Additionally, a cost-benefit analysis of using quinoa in comparison with fat sources of animal origin should be performed.

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