Nutrition and Food Sciences Research Vol 2, No 3, Jul-Sep 2015, pages: 55-62

Original Article

Considering the Physicochemical and Sensorial Properties of Momtaze Hamburgers Containing Lentil and Chickpea Seed Flour

Amir Motamedi*, Marzieh Vahdani, Homa Baghaei, Monire Alsadat Borghei

Department of Food Science and Technology, Damghan branch, Islamic Azad University, Damghan, Iran.

Received: March 2015 **Accepted:** June 2015

ABSTRACT

Background and Objectives: The food product known as the 'hamburger' plays a crucial role in people's nutrition and the diversity of the food they consume. The reasons for our study include the area under cultivation, the remarkable amount of protein in chickpeas and lentils, as well as the public interest in tending to meat products, especially hamburgers.

Materials and Methods: In this study, beef burgers were combined with chickpea flour and lentil flour at 4%, 8% and 12% levels. We evaluated the properties of uncooked beef burgers, including protein, fat, moisture, ash, pH, texture profile (hardness, springiness, cohesiveness, gumminess and chewiness), cooking properties, and sensory attributes.

Results: Compared with the controls, the percentage of the samples' protein and fat increased with the rise in the level of chickpea and lentil flour. At 12% level, the chickpea and lentil flour had the lowest ash content. Samples of hamburgers with lentil flour at 12% level had the highest pH value. The hardness, chewiness and gumminess value of the samples significantly increased with increase in the level of chickpea and lentil flour, compared to the controls. At the level of 12%, the lentil flour had the lowest shrinkage percentage. Scores for all sensory parameters except for appearance decreased with increase in the level of extension.

Conclusions: We successfully produced a new product with significant nutritional value, cooking features and acceptable sensory-textural properties. Hamburger with 4% content of chickpea or lentil flour had sensory properties similar to the control, and was rated close to very good. Further research should be focused on the optimized use of amounts of legumes in hamburger.

Keywords: Chickpea flour, Formulation, Hamburger, Lentil flour, Physico-chemical properties

Introduction

Meat products in Italy, Spain, Ireland and Turkey are about 30% of the cost of the related food products with 25% for England, Holland and Greece, as well as 35% for Denmark, France and Belgium (1). The growing population of the world has forced humans to turn to new food resources and, in particular, protein resources. Protein resources chiefly come from animal protein (2). As the urban population increases, new circumstances have reduced our physical access to food (e.g., fruit and vegetables). Consequently, for economic prosperity of their family, people are forced to spend more hours of the day outside of their homes. As a result, the fast food market has flourished. The food product known as the 'hamburger' plays a crucial role in the nutrition and diversity of the food people consume. Meat is the main component of this product. Meat is one of the most important food elements for humans. It is very rich in protein and meets the body's needs. In terms of necessary amino acids, meat is a good source of high quality protein. Furthermore, it has additional B-complex vitamins and special minerals, iron in

***Address for correspondence:** Amir Motamedi, M.sc, Food science and technology Department of Food Science and Technology, Damghan branch, Islamic Azad University, Damghan, Iran. E-mail address: Amirmotamedi1987@yahoo.com

particular (3). A healthy society should not hesitate to provide protein, a principal source of nutrition. Today, animal protein is recognized as a human need. Special meat products supply a portion of consuming protein with its replacements, at the rate of meat consumed per capita. As a result, society's nutritional and economical needs are met (3). With meat in its ingredients and a desirable flavour, hamburger is considered to be an easy-to-consume meat product (4). Due to its price variation, fast food can be purchased by everyone, from the wealthiest to the most destitute class of society (5). One of the most widely consumed food products is meat. Germany is one of the biggest producers of meat products; it has over 100 types of meat products with different names (6). For a large number of people, varying in both social status and age, a significant portion of their daily food intake comes from different types of hamburger (7). Enriching them at any level can be useful in improving the health of individuals and society (8). After cereal, the second most important type of crop is legume. The protein percentage in legumes varies between 17.1% and 25.2%. For cereals including wheat, rice and corn, the protein percentage is 11.8%, 8.5% and 11.1%, respectively. Furthermore, the protein percentage of a lentil is equal to a bean. This is more than a chickpea, and two times more than the protein percentage in wheat (9). Recently, there have been several studies about the role of legumes in growing functional foods. Legumes contain the necessary vitamins, minerals, proteins, dietary fibres and energy for human health. Legumes are considered to be the meat of the poor. They are rich in protein, and supply slow release carbohydrates. Diverse metabolic diseases like mellitus, coronary heart disease and colon cancer could be controlled and prevented by including legumes in a daily diet (10). This would have many physiological effects. The reasons for our study include the area under cultivation, the remarkable amount of protein in chickpeas and lentils, as well as the public interest in tending to meat products, especially hamburgers.

Materials and Methods

The chickpeas (Cicer *arietinum*) and lentils (Lens culinary) used in this study were prepared at the Institute of Agricultural Research, Khorramabad city, Iran (Table 1). The boneless beef round, onions, wheat flour and salt were prepared at the local market. Next, they were soaked in water for 3 hours, with the volume ratio of 1:8 legume to water (9). They were then placed in boiling water for half an hour. The chickpea and lentils were separately dried in an electric oven (100 °C) for 5 hours and ground in a mill. After being grounded with an industrial mill, the seeds were passed through a sieve mesh 16.

Table 1. Proximate composition (g/100 g) of different legumes

Legume	Protein	fat	ash
Chickpeas	20.48%	5.46%	2.85%
Lentils	25.69%	1.45%	2.73%

Chickpea and lentil analysis: The fat, protein, ash and moisture of chickpeas and lentils were based on AACC, 2000 (11).

Sample preparation: The control hamburgers were prepared based on a commercial formulation containing 62% meat, 18.5% onion, 1.25% salt, 1.25% spices, 5% wheat flour, and 12% rusk flour (Table 2).

Samples were made with three levels of legume flour (4%, 8% and 12%) instead of rusk flour, and were compared to the control formulation. After preparation, the hamburger samples were moulded and stored in zipped nylons in a -18°C freezer. To defrost the hamburger samples, they were kept in a fridge at 5±2°C for 72, and then in the refrigerator just 12 hours before the test at 2 ± 5°C.

Table 2. Product formulation for different flour hamburgers

Ingredients	Control	CF			LF		
		4%	8%	12%	4%	8%	12%
Meat (%)	62	62	62	62	62	62	62
Onion (%)	18.5	18.5	18.5	18.5	18.5	18.5	18.5
Salt (%)	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Spices (%)	1.25	1.25	1.25	1.25	1.25	1.25	1.25
Wheat flour (%)	5	5	5	5	5	5	5
Rusk flour (%)	12	8	4	-	8	4	-
Legume flour (%)	-	4	8	12	4	8	12

CF= Chickpea Flour
LF= Lentil Flour

Texture analysis: Analysis of texture profile on raw samples was conducted with a Texture Analyser (Texture Analyser/USA/Lloyd Version 3:4) following the standard procedures. Cubic samples (1×1×1 cm) were cut from patties suitable for a two-cycle compression test. The samples were compressed to 50% of their original height by a cylindrical probe of 10 cm diameter at a compression load of 25 kg and an across-head speed of 20 cm/min (12).

The extreme force required to compress the samples was the hardness (Kg). Cohesiveness (without unit) was the limit to which the rupture (A_1/A_2) could be deformed following the samples. A_1 was the overall energy needed for the first compression, and A_2 was the total energy needed for the second compression (12).

The springiness (cm) included the capability of the samples, following the removal of the deformation force to recover its original shape. The gumminess (Kg) was the force used to break into the semi-solid meat samples to swallow (hardness-cohesiveness). The chewiness (Kg-cm) was the work required to chew the samples to swallow (springiness-gumminess) (12).

Proximate compositions measurements: The proximate compositions of the hamburgers including fat, ash, protein and moisture measured were based on AOAC, 2003 (13).

The pH of each hamburger sample was measured using the AOAC method (2003) (13).

Cooking and cooking measurements: The hamburgers were cooked at 175°C for 6 minutes in an electric grill machine (Philips, Model 4466HD, Made in China), giving an internal temperature of 175 °C. The thickness and diameter of hamburger were measuring by a digital calliper (Guanglu, Model 75400RZ, made in China). The reduction in the hamburgers' diameter, and increase in their thickness and shrinkage of the hamburgers were calculated according to Serdaroglu and Degırmencioglu, 2004 (14). Cooking yield was determined according to Prabpree and Pongsawatmanit (2011) by weighing the samples before and after cooking. (15):

$$\text{Cooking yield\%}=\frac{(\text{Uncooked weight}-\text{cooked weight})}{\text{Uncooked weight}} \times 100$$

The reduction in the hamburgers' diameter percentages was calculated through the following equation:

$$\text{Reduction in hamburger diameter \%} = \frac{(\text{Uncooked diameter}-\text{cooked diameter})}{\text{Uncooked diameter}} \times 100$$

The increase in the hamburgers' thickness percentages was calculated by the following equation:

$$\text{Increase in hamburger thickness \%} = \frac{(\text{Cooked thickness}-\text{uncooked thickness})}{\text{Uncooked thickness}} \times 100$$

The shrinkage percentages were calculated as below:

$$\text{Shrinkage\%} = \frac{(\text{Cooked thickness}-\text{uncooked thickness})+(\text{cooked diameter}-\text{uncooked diameter})}{\text{Uncooked thickness}+\text{uncooked diameter}} \times 100$$

Sensory evaluation: The sensory evaluation parameters were colour, texture, taste, appearance and overall palatability. The samples were assessed by a 10-membered trained panel (academic staff of Food Technology Department, Damghan University, Iran) Recruitment, selection and training of panellists were performed according to the sensory evaluation procedure (Mohammadi et al, 2012).Ten panellists were screened out of the 13 potential panellists (16). The evaluation form was prepared based on a 7-point Hedonic scale (1= extreme dislike and 7= extreme desire). Water was applied to rinse the mouth between the samples.

Statistical analysis: The data obtained from the cooking measurements, proximate compositions and texture analysis measurements to compare the average were analysed by the use of completely randomized design with three replications. The results were reported as the mean ±standard deviation, and subjected to analysis of variance (ANOVA) using the SPSS software (ver.18). Finally, Duncan's multiple range test was run to assess any statistically significant difference between the obtained mean values in each experiment at P<0.05.

Results

Proximate composition: The mean values for the proximate of uncooked hamburgers are shown in Table 3. Adding chickpea and lentil flours increased the percentage of fat (in the samples with 12% chickpea flour 11.6% and lentil flour 11.46%) compared to the controls. Also, based on the ANOVA results, we saw a significant increase in protein (in the samples with 12% chickpea flour 15.19% and lentil flour 15.34%) with the rise of replacement level. We found that adding chickpea and lentil flour had no significant effect on the moisture of the samples. Additionally, adding chickpea and lentil flours decreased the percentage of ash in the samples compared to the controls.

pH: The pH values of different samples are given in Fig. 1. The controls had the lowest pH (5.88) and the samples with 12% chickpea (6.04) and lentil (6.05) flours had the highest pH.

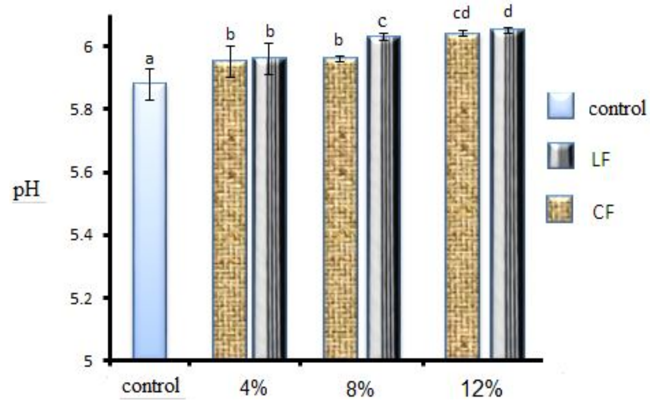

Fig 1. Mean values of treatments for pH analysis of hamburger samples by addition different levels of legume flour.

CF= Chickpea Flour, LF= Lentil Flour.
Different letters: indicates the significant differences of each shape (P<0.05).
The numbers are the mean of three replications ± standard deviation.

Table 3. The chemical composition of the uncooked hamburger samples affected by adding various levels of chickpea and lentil seed flours

Type of the burger		Fat (%)	Ash (%)	Protein (%)	Moisture (%)
Control		10.80±0.10 ^{a}	2.28± 0.03^{a}	13.58±0.11^{a}	58.54±0.12^{a}
CF	4%	10.85±0.06^{a}	2.24±0.02^{ab}	14.11±0.05^{b}	58.56±0.05^{a}
	8%	11.43±0.38^{cd}	2.17±0.02^{c}	14.57±0.08^{c}	58.68±0.07^{a}
	12%	11.6±0.09^{d}	2.11±0.01^{d}	15.19±0.09^{d}	59.22±0.21^{a}
LF	4%	11.15±0.08^{bc}	2.22±0.03^{b}	14.25±0.02^{b}	58.54±0.09^{a}
	8%	10.87±0.13^{ab}	2.15±0.02^{c}	14.59±0.21^{c}	58.79±0.17^{a}
	12%	11.46±0.08^{d}	2.04±0.02^{e}	15.34±0.09^{d}	59.26±0.62^{a}

CF= Chickpea Flour, LF= Lentil Flour.
Different letters: indicates the significant differences of each column.
The numbers are the mean of three replications ± standard deviation (P<0.05).

Cooking properties: The cooking parameters of the samples are given in Table 4. Based on the ANOVA results, the control samples had the maximum diameter reduction and shrink percentage. Furthermore, the samples with 12% chickpea and lentil flours had the minimum diameter reduction (chickpea flour 13.02% and lentil flour 12.77%) and shrink percentage (chickpea flour 13.52% and lentil flour 12.59%).

Texture analysis: Texture analysis of the samples is given in Table 5. Based on the ANOVA results, an increase in the replacement level of legume flour led to a significant increase in the hardness, gumminess and chewiness of the samples, compared to the controls.

Sensory properties: The sensory scores of the samples are given in Table 6. The control samples had the highest overall acceptability score, and the samples with 12% chickpea and lentil flour, had the lowest score. The sensory results are consistent with the study of Bhat and Pathak, 2011 (17).

Table 4. The cooking parameters of the hamburger samples affected by the addition of different levels of chickpea and lentil seed flour

Type of the burger		Reduction in diameter (%)	Thickness increase (%)	Cooking yield (%)	Shrinkage (%)
Control		19.60±0.85^{a}	34.01±4.04^{a}	6.14±0.32^{a}	20.93±0.49^{a}
CF	4%	16.33±0.85^{b}	21.53±0.70^{b}	6.42 ±0.67^{ab}	16.84±0.76^{b}
	8%	15.21±0.38^{c}	20.46±1.16^{bc}	7.04 ±0.95^{ab}	15.50±0.54^{c}
	12%	13.02±0.23^{ef}	14.11±0.83^{de}	7.84±0.93^{bc}	13.52±0.58^{de}
LF	4%	14.77±0.61^{cd}	20.09±0.95^{bc}	6.37±0.51^{ab}	15.28±0.57^{c}
	8%	13.94±0.53^{d}	17.20±1.52^{cd}	6.46±0.12^{ab}	14.28±0.42^{d}
	12%	12.77±0.36^{f}	11.03±0.68^{e}	7.64±0.85^{bc}	12.59±0.27^{e}

CF= Chickpea Flour, LF= Lentil Flour.
Different letters: indicates the significant differences of each column ($P<0.05$).
The numbers are the mean of three replications ± standard deviation.

Table 5. Texture analysis parameters of the control and treated hamburgers

Product		Hardness (Kg)	Cohesiveness (-)	Gumminess (Kg)	Chewiness (Kg-cm)	Springiness (cm)
Control		5.94±0.63^{a}	97.73±3.84^{a}	580.75±24.8^{a}	310.30±16.85^{a}	0.508±0.06^{a}
CF	4%	6.46±1.63^{a}	97.91±3.13^{a}	632.31±27.81^{a}	380.42±26.03^{ab}	0.548±0.027^{a}
	8%	6.63±0.6^{ab}	104.29±3.33^{a}	690.03±18.21^{ab}	365.40±12.31^{a}	0.522±0.103^{a}
	12%	8.01±0.44^{b}	101.71±2.5^{a}	814.69±14.21^{b}	484.79±25.70^{b}	0.566±0.09^{a}
LF	4%	6.4±0.51^{a}	99.34±4.32^{a}	634.12±16.9^{a}	348.04±20.42^{a}	0.548±0.04^{a}
	8%	6.72±0.8^{ab}	106.19±4.27^{a}	717.75±8.5^{ab}	368.02±16.61^{a}	0.526±0.07^{a}
	12%	7.97±0.74^{b}	106.92±3.8^{a}	825.56±9.54^{b}	483.48±12.9^{b}	0.567±0.13^{a}

CF= Chickpea Flour, LF= Lentil Flour.
Different letters: indicates the significant differences of each column ($P<0.05$).
The numbers are the mean of three replications ± standard deviation.

Table 6. Sensory scores of the control and treated hamburgers

Type of the burger		Colour	Flavour	Texture	Appearance	Overall acceptability
Control		5.8±0.63^{a}	5.9±1.73^{a}	5.8±0.82^{a}	5.3±0.48^{a}	6.4±0.51^{a}
CF	4%	5.2±0.78^{ab}	5.5±0.71^{ab}	5.3±0.67^{ab}	5.3±0.67^{a}	5.6±0.51^{b}
	8%	4.7±0.82^{b}	4.7±0.48^{cd}	4.6±0.70^{c}	5.6±0.70^{a}	4.7±0.82^{c}
	12%	3.7±0.67^{c}	4.2±0.63^{d}	4.4±0.51^{c}	5.8±0.70^{a}	4.2±0.62^{c}
LF	4%	5.6±0.7^{a}	5.5±0.7^{ab}	5.4±0.96^{ab}	5.4±0.70^{a}	5.6±0.92^{b}
	8%	4.8±1.03^{b}	5.2±0.42^{bc}	4.8±0.42^{bc}	5.4±0.52^{a}	5.3±0.82^{b}
	12%	4.6±0.84^{b}	4.4±0.73^{d}	4.7±1.94^{c}	5.9±0.74^{a}	4.3±0.83^{c}

CF= Chickpea Flour, LF= Lentil Flour.
The numbers are the mean of 10 panelists of ± standard deviation ($P<0.05$).
Different letters indicate the significant differences of each column.

Discussion

In this study, the amount of fat in the chickpea and lentil flours was 5.8 and 1.5%, respectively. As a result, it is clear to see that the amount of fat in the entire hamburger samples containing chickpea and lentil flours increases from 10.8% in the control sample to 11.46% in the lentil and 11.6% in the chickpea samples. Though these increases were not important technologically; they were statistically meaningful. The controls had the lowest percentage of protein and fat. Additionally, the sample with 12% chickpea flour and lentil flour had the highest percentage of protein and fat. Hegazy (2011) found that replacing fenugreek at four levels (3%, 6%, 9%, and 12%) instead of soy flour in beef hamburgers significantly increased the fat content of the samples, compared with the control (18). The protein content of the controls was significantly lower than of other burgers, due to the high protein content of legume flour. Jokar et al. (2011) reported that adding the germinated chickpea flour increased the protein level of sausages (8). The samples with 12% chickpea and lentil flours had the lowest ash and the highest ash percentage. The control hamburgers were prepared with 3.4% ash content (based on tests); thus, while replacing them with a lower ash content of legume flour with 2.8% chickpea and 2.7% lentil, the ash of the samples with legume flour decreased as compared to the controls. Ali et al. (2011) reported that the hydrated rice flour in beef sausages reduced the ash percentage (19). Moisture content of the burgers ranged from 58.54 to 59.26%, and there was no significant difference among the burger samples. In the treatment samples, the pH ranged from 5.88 to 6.05, and was significantly different among the different treatments. The increase of pH in the samples could be the result of the increase in amine compounds in the samples with chickpea and lentil flour due to increase in their protein content. Legume contains plenty of alkali amino acids like Arginine and Lysine and also plenty of acidic amino acids like Aspartic and Glutamic acids (20). These results are consistent with the study of Bhat and Pathak, 2011 (17). All treatments had a reduction in hamburger diameter and thickness. On average, the samples containing lentils had the percentage of diameter reduction (13.82), thickness increase (16.106%), and shrinkage (14.05%). The hamburgers tend to shrink during the cooking process due to the denaturation of the meat proteins (21). Cook losses depend on a number of different variables such as composition, additives, cooking methods, and oven temperature, and sample dimensions. It has also been indicated that cook losses are mainly due to water and fat decreases, which in turn depend on the mass transfer process during the thermal treatment (21). The lowest shrinkage was recorded in the treatment with 12% chickpea and lentil flour (Table 3). As in the case of diameter reduction (19.60%), the highest ‘‘thickness increase” (34.01%) was observed in the control hamburger. Maintaining the cooking, especially the appearance, features of the product such as diameter, thickness and shrinkage was considered to be beneficial. This means that, in spite of the rise in the nutritional value of the product due to adding the chickpea and lentil flours, the cooking parameters were not reduced. The results are consistent with the study of Sharaf et al. 2009 (22). The cooking yield indicates the weight of material that the hamburgers lost during cooking; this was achieved by the weight difference of the product, before and after cooking. The samples with 12% chickpea and lentil flour had the lowest for the treatment cooking yield (7.84%, 7.64%, respectively) and the highest cooking yield (6.14%) for the control (Table 3). Since the time and temperature were the same for all samples, the decline in cooking yield may be the result of increase in moisture and fat percentage of the samples. The results are consistent with the study of Verma et al, 2012 (23). Texture profile analysis is a very useful technique for evaluating food quality in product development. In the present study, the hardness values of hamburger increased significantly with increase in the level of chickpea and lentil flour contents (Table 4). The lowest level of hardness, gumminess and chewiness was related to the control samples. The highest level of hardness is related to the 12% sample of the chickpea and lentil flour (8.01% and 7.97% respectively). The increase in hardness can be attributed to the increase of protein in the samples with chickpea and lentil flours. Increased amount of protein leads to increased connections in product. At a level of 4%, the chickpea and lentil flour (4.46 and 6.4 respectively) had no significant difference, compared to the control samples (5.94). The gumminess of this parameter was obtained by multiplying the hardness by the cohesiveness amount (24). Since the hardness of the samples increased with increase in the level of protein; therefore, the related parameters were increased too. The chewiness of this parameter was obtained by multiplying the springiness by the gumminess (24). The comparison of the average data indicated that adding chickpea and lentil flours had no significant effect on the amount of springiness and cohesiveness of the produced hamburgers as compared to the control. The results of texture analysis are consistent with the study of Prabpree and Pongsawatmanit, 2011 (15). Data for sensory evaluation is presented in Table 5. There were significant differences in colour, flavour, texture and overall acceptability among the hamburgers prepared with chickpea and lentil flours. An increase in the level of the chickpea and lentil flour hamburgers reduced the colour score of the samples. Generally, the control hamburgers had the highest colour score (5.8) and the hamburgers with 12% chickpea flour had the lowest colour score (3.7) compared to the controls. The low colour score of the hamburgers with chickpea flour could be due to the bright yellow colour of the chickpea flour. Studies show that consumers do not like the bright yellow colour in hamburgers and sausages (25). The addition of 4% chickpea and lentil flours in the formulation had no significant effect (5.2 and 5.6, respectively) on the sensory attributes of the products. The control samples had the highest sensory score (5.8), and the samples with 12% chickpea (4.4) and lentil (4.6) flours had the lowest sensory score. The results of texture analysis showed that, with increase in the level of chickpea and lentil flours, the samples became stiffer than the control samples; these results prove the scores. The decrease in texture scores at higher levels of extender may be due to higher connections created in the product's texture as a result of increased structural meat proteins by the addition of legume flour. Flavour score deceased as a result of dilution of meaty flavour due to increase in the replacement level. The control samples had the highest taste score (5.9) and the samples with 12% chickpea and lentil flours had the lowest taste score. This could be because people do not like the sharper flavour of legume, arguably covering the pleasant taste of meat in the treated hamburgers. Some people believe that adding chickpea and lentil flour increases the appearance score of the samples with legume flour compared to the control samples. However, this increase was not significant (samples with 12% chickpea flour 5.8 and lentil flour 5.9). The results of cooking parameters prove the score because the samples with legume flour had diameter reduction, thickness increase, and a lower percentage of shrinkage compared to the control samples. Based on the analysis of the variance, the increase in the level of chickpea and lentil flours reduced the overall acceptability of the hamburger samples with legume flour (samples with 12% chickpea flour 4/2 and lentil flour 4/3).

The results of this study suggest that chickpea and lentil flours can be acceptably used in the formulation of Momtaze hamburgers, instead of rusk flour. Thus, we are able to produce a new product with significant nutritional value, cooking features and acceptable sensory-textural properties. Hamburger with 4% chickpea or lentil flour content had sensory properties similar to the control, and was rated close to very good. Further research should focus on the optimized use of amounts legumes in hamburger production.

Financial disclosure

The authors declared no financial interest.

Funding/Support

The study did not receive any financial support.

References

1. Zeinalzadh A, Mirzai M, Chamani M, Gerami E. Effect of diet fiber of corn trim gluconate calcium on the quality characteristics of sausages. Food Technology and Nutrition 2010; 7:5-16.
2. Alaviyeganeh MS, Abediankenari E, Rezai M. Effect of gammarus powder as a supplementary diet on growth and survival of rainbow trout larvae (Oncorhynchus mykiss). Pajouhesh and Sazandegi 2008; 77: 113-123.
3. Maghsoudi S, editor. The making of burger. 2th ed. Tehran: Agricultural Sciences 2008. p. 2-10.
4. Haddad-khodaparast MH, Mahdavianmehr H, Hosseini Z, Yousof-Ali M. Antimicrobial effect of Salvia leriifolia leaf extract against the growth of Staphylococcus aureus in meat products. Congress of Horticultural Sciences, University of Guilan 2010; 6: 2148-2152.
5. Yaghoobifar MA, Shakerinejad A, Akaberi A. Comparing the quality and safety of sausages marketed in Sabzevar. Journal of Sabzevar University of Medical Sciences 2009; 16: 120-114.
6. Rokni N, editor. Sciences and meat industry. 5th ed., Institute of Tehran University 2008. p. 128-131.
7. Kamkar A, Rokni N, Rasoli A, Shirodi AA. The assessment of the quality of hamburgers using collagen levels. Research and Development in Livestock and Aquaculture 2004; 63: 79-75.
8. Jokar A, Hasheminasab A, Ghena'atzadeh L, Farahnaki A, Hosseini M. Using germinated bean flour instead of wheat flour in the production of sausages, German. Iranian Food Science and Nutrition. 2012; 7: 118-111.
9. Pars M, Bagheri A., editors. Legume. First ed., Jihad-e Daneshgahi of the Mashhad University 2008. p. 30-35.
10. Serdaroglu M, Turp YG, Abrodimov K. Quality of low-fat meatballs containing Legume flours as extenders. Meat Science 2005; 70: 99–105.
11. AACC Method 56-20 2000. American Association of Cereal Chemists Approved Methods. St. Paul, Minn. American Association of Cereal Chemists.
12. Fernandez-Lopez J, Jimenez S, Sayas-Barbera E, Sendra E, Perez-Alvarez J A. Quality characteristics of ostrich (Struthiocamelus) burgers. Meat Science 2006; 73: 295–303.
13. AOAC. (2003). Official Methods of Analysis (14th ed.). Association of Analytical Chemists, Washington DC.
14. Serdaroglu M, Degırmenciogl, O. Effects of fat level (5%, 10%, 20%) and corn flour (0%, 2%, 4%) on some properties of Turkish type meatballs (koefte). Meat Science 2004; 68: 291–296.
15. Prabpree R, Pongsawatmanit R. Effect of tapioca starch concentration on quality and freeze-thaw stability of fish sausage. Kasetsart Journal Nattural Science 2011; 45: 314 – 324.
16. Mohammadi M, Oghabi F. Development of low-fat and low-calorie beef sausage using modified starch as fat replacement agent. J Sci Food Agric 2012; 92:1291-6.
17. Bhat ZF, Pathak, V. Effect of black bean (Vignamungo) on the quality characteristics of oven-roasted chicken seekhkababs. Journal of Stored Products and Postharvest Research 2011; 2: 15 – 23.
18. Hegazy AI. Influence of using fenugreek seed flour as antioxidant and antimicrobial agent in the manufacturing of beef burger with emphasis on frozen storage stability. World Journal of Agricultural Sciences. 2011; 7: 391-399.
19. Ali MS, Kim GD, Seo HW, Jung E Y, Kim B W, et al. Possibility of making low-fat sausages from duck meat with addition of rice flour. Asian-Australasian Journal of Animal Sciences 2011; 24:421-428.
20. Swanson BG. Pea and lentil protein extraction and functionality. Journal of the American Oil Chemists Society 1990; 67: 276–280.
21. Changyi H, Cho H, Hong JJ, Ryu RK, Hwang kT, et al. Physicochemical and organoleptic characteristics of seasoned beef patties with added glutinous rice flour, Meat Science 2012; 92: 464–468.
22. Sharaf AM, Ebrahium ME, Ammar MS, Abdel-Ghany ME. Influence of using Moringa meal flour as meat extender on quality characteristics of beef burger patties during frozen storage. World Journal of Dairy & Food Sciences 2009; 4: 32-40.
23. Verma AK, Banerje R, Sharma BD. Quality of low fat chicken nuggets: Effects of Sodium Chloride replacement and added chickpea (Cicerarietinum L) hull flour. Asian-Australasian. Journal of Animal Sciences 2012; 25: 291-298.
24. Sanchez-Zapata E, Munoz CM, Fuente SE, Fernandez-Lopez J, Sendra E, Sayas, et al. Effect of tiger nut fibre on quality characteristics of pork burger. Meat Science 2010; 85:70–76.
25. Abedini M, Varidi MJ, Shahidi F, Marashi SH. Study on the effect of melon seed flour as a fat replacement for chemical and sensory characteristics of meat products. Food Science Quarterly 2009; 6: 57-51.