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Original Article

Effect of Addition Watermelon Rind Powder and Watermelon Seed Powder on the Rheological, Physiochemical, and Sensory Quality Attributes of Functional Diet Burger

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ABSTRACT

Introduction: Watermelon seeds have many nutrients, and watermelon seeds are also rich in fatty acids, proteins and minerals. Recently, the role of dietary fiber on health and nutrition has been highly considered. Lack of fiber increases the risk of diseases.
Materials: In this research, using watermelon rind and seed powder at specific levels as a source of dietary fiber and fat substitute in the formulation, the physicochemical, cooking, and sensory properties of the final product are investigated.
Results: No significant difference was observed in the control sample and the 4% watermelon peel powder sample. No significant difference was observed in the amount of moisture in different hamburger samples. In all the samples, with the increase in the replacement percentage, the protein also increased. The control sample has the highest amount of ash. The pH of the control sample was significantly lower than all the samples. In both samples, the pH was 4% more than the control. The control hamburger had the highest score (4.8) and the hamburgers containing 12% watermelon seed flour had the lowest color score (2.7) compared with the control sample.
Conclusion: The results of the present research showed that the use of watermelon peel powder as a source of dietary fiber and watermelon seed powder in hamburger as a meat product can be used in the formulation of premium hamburger, and thus new products with significant nutritional value, properties produce an acceptable texture and feel.
Keywords: Watermelon, Powder, Burger

1. Introduction

There is a direct relationship between the type of diet and the risk of some diseases such as colon cancer, obesity, and cardiovascular diseases. Therefore, the increasing concerns about the potential risks associated with the consumption of high-fat foods have led food industry to develop new formulations and modify traditional food products to lower fat content. Today, fat substitutes have

opened new ways to produce diverse and new low-fat foods with a pleasant taste and texture like high-fat products, but do not contain unnecessary calories and cholesterol. In different studies, the use of substitutes such as hydrocolloids (carrageenan, agar, and alginate), cellulose, inulin, plant seed gum, guar, various starches, processed plant compounds (such as wheat bran, products made from soy, bran, and oat fiber), types of citrus fiber and vegetable seeds, esterified vegetable oils and other compounds have shown satisfactory results in the production of various low-fat meat products [1].

Increasing interest of people in the society for fast-prepared foods has caused changes in socio-economic factors in recent years. Today, various efforts are being made to improve and stabilize such products, including the use of some non-meat protein substances or non-protein hydrocolloids in meat products to improve the rheological and nutritional reducing the amount of fat [2].

Watermelon peel has 93.8% moisture, 0.49% ash, 0.1% nitrogen, and 1.2% sugar. Also, the fiber of watermelon peel contains about 20% cellulose, 23% hemicellulose, 10% lignin, 13% pectin, and according to studies conducted, watermelon peel contains 2.2 mg/g of dry matter weight of the amino acid citrulline. In addition, watermelon rind has more potassium than watermelon flesh, while its sugar content is lower. Watermelon peel powder is a good source of dietary fiber and biologically active compounds. Therefore, it can be used in food industries as a functional ingredient, which has nutritional properties in addition to the benefits of dietary fiber. Among the benefits of watermelon peel: reducing blood sugar, reducing blood pressure, improving the performance of athletes, reducing cardiovascular problems, solving men's sexual problems, and improving the immune system [3, 4].

Likewise, citrulline amino acid found in watermelon peel, this amino acid helps to create the essential amino acid arginine in the body and beneficial for the health of the heart, blood vessels, and the body's immune system. Amino acid citrulline intensifies the production of nitric oxide from urea in the body, which relaxes the walls of blood vessels and increases the sexual power of men [5, 6].

Therefore, in this research, using watermelon peel powder as a source of dietary fiber and watermelon seed powder in samples as a meat product, the effect of the presence of these compounds on physical properties (water holding capacity, texture, color, and sensory properties) is tried, chemical properties (fat, moisture, protein, ash, carbohydrates, and pH), cooking properties (cooking efficiency and shrinking) and sensory properties of the produced functional diet burger should be evaluated and according to the examined cases, the best available formulation for sensory properties should be evaluated to determine the production product.

2. Materials and Methods

Making burgers

After preparing the burger according to the formulations presented in Table 1, the control formulation using research, to investigate the physical properties (water retention capacity, texture, color, and sensory properties), chemical properties (fat, moisture, protein, ash, carbohydrates, and pH), cooking properties (yield and shrinking) and sensory properties of the produced functional diet burger should be evaluated and according to the investigated cases, the best available formulation should be determined for the sensory properties of the manufactured product.

Table 1. Introduction of the treatments used in the research [7]

Onion powder	Black pepper	Garlic powder	Salt	Soya	Water	Watermelon seed powder	Watermelon peel powder	Fat	Veal	Treatment.
0.4	0.05	0.05	0.9	1.8	15	--	--	16.8	65	Control
0.4	0.05	0.05	0.9	1.8	15	1	3	12.8	65	1
0.4	0.05	0.05	0.9	1.8	15	1	6	9.8	65	2
0.4	0.05	0.05	0.9	1.8	15	1	9	6.8	65	3
0.4	0.05	0.05	0.9	1.8	15	2	3	11.8	65	4
0.4	0.05	0.05	0.9	1.8	15	2	6	8.8	65	5
0.4	0.05	0.05	0.9	1.8	15	2	9	5.8	65	6
0.4	0.05	0.05	0.9	1.8	15	3	3	10.8	65	7
0.4	0.05	0.05	0.9	1.8	15	3	6	7.8	65	8
0.4	0.05	0.05	0.9	1.8	15	3	9	4.8	65	9

Physical tests

Evaluation of cooking properties

After preparing the burgers according to the formulation presented in Table 1, the samples are placed in the oven tray and covered with aluminum foil. Then, it is cooked in the oven at 150 °C for 15 minutes. Cooking efficiency and shrinkage rate were determined using the method applied by BIS-SOUZA *et al.* in 2018.

Texture evaluation

Tissue characteristics were determined using a tissue profile analysis device. Hence, after cooking the burger at a temperature of 150 °C and cooling it at room temperature, circular samples with a diameter of 2 cm were prepared and their textural characteristics were obtained using a flat probe with a diameter of 2.5 cm under a load cell of 25 kg. Force, movement speed of 1 mm/s was checked. The force required to compress the sample to 50% of the original height was measured and the stiffness, elasticity, adhesion, continuity, and chewing ability were determined using the resulting graph [8, 9].

Color evaluation

Currently, the most common way to measure the color of food is to use the Huntlab device. L*a*b* or CIELab is a global standard published in 1976 by the International Commission on Illumination (CIE), where L* represents luminance ranging from 0 for black to 100 for white and a* represents The degree of redness (from -60 for green to 60 for red) and b* represents the degree of yellowness (-60 for blue and 60 for yellow). L*a*b* is specific and uniform in terms of color formation and perception and is done using different devices. Color is checked by colorimeter by determining color characteristics [10,11].

Water Holding Capacity (WHC)

20 g of the burger sample is placed between two Whatman filter papers, which have been previously weighed, and the sample is centrifuged for 20 minutes with g9500. According to the amount of water removed from the tissue of the sample, the water holding capacity is calculated according to equation 3 [12,13].

Assessment of total fat

This method is based on boiling the product with dilute hydrochloric acid, releasing the un-free and combined fat, and then filtering, drying and extracting the remaining fat on filter paper using n-hexane or light petroleum as a solvent [14].

Moisture assessment

The basis of this method is mixing the product with sand completely, and then drying at a temperature of 103 °C based on the Iranian national standard test method No. 745 [15].

Assessment of carbohydrate content

The steps of the method include heating a certain amount of sample with hydrochloric acid solution in order to dissolve all the ingredients of the meat and completely hydrolyze, cooling, and adjusting the pH and adding precipitating substances, filtering, and re-adjusting the pH to the appropriate amount, measuring glucose. It is formed using Fehling's solution [16] .

Evaluation of the total protein

It includes the complete digestion of organic materials against concentrated sulfuric acid, potassium sulfate, and selenium oxide catalysts organic nitrogen materials into mineral nitrogen materials, distillation and measurement of the amount of nitrogen, which, taking into account the protein coefficient (6.25) is the amount of total protein. It is calculated according to nitrogen [17].

Ash evaluation

It consists of drying, carbonizing, and then burning the sample at 550 ± 25 °C, and then cooling and finally determining the resulting residue [18].

pH assessment

5 g of burger samples were mixed with 45 ml of distilled water for 30 seconds by a model mixer (ELM 2000, made in Germany), and then the pH of the sample was determined by a model pH meter device (Eutech, made in Singapore) [19].

Sensory properties test

To determine the overall acceptability of the final product by consumers out of 10 evaluators (5 women and 5 men), be used to conduct the test and they will be asked to give the samples 5-point overall hedonic pleasure attributes (5=excellent, 4=good, 3=moderate, 2=weak, and 1=bad), vote from very favorable to very unfavorable. The sensory properties of taste, aroma, texture, and overall acceptance will be evaluated by the judges. Then, the qualitative data was converted into the quantitative data, in this way; points from 1 to 5 were given to very unfavorable to very favorable expressions. Before starting the evaluation, the evaluators are asked to wash their mouths, and also use salt-free biscuits. This process should be repeated after testing each sample [20].

Data analysis methods

Statistical analysis in this research will be done using SPSS21 software. Factorial experiment in the form of randomized complete block design (for sensory data) and factorial experiment in the form of completely randomized design (for physicochemical data) will be used. In the case of sensory data, to remove the variance resulting from the difference between evaluators, each judge, or evaluator will consider a block. The mean of experimental treatments will be compared with each other using Duncan's test [21, 22].

3. Results and Discussion

Chemical compounds of watermelon and watermelon rind

The chemical compositions of watermelon seed flour and watermelon peel are presented in Table 2. There is a significant difference in watermelon seeds and peel; the seed showed about 5.5% fat, and the peel showed about 1.5%. Regarding protein, this difference was also significant, but the numbers were closer. Regarding ash and moisture, it is worth to note that there was no significant difference. Marand *et al.* and Mousavi *et al.* found that fat values of meat samples added flaxseed were higher than control sample. These results are in line with our results. In addition, many factors such as formulation ratio could affect the fat values of Meat. Similarly, Atik *et al.* reported that pH and acidity values of meat samples were affected by the addition of chia seed mucilage (1, 2, and 3%) and storage. Mihoubi *et al.* found that ash amount of the watermelon seed containing %2.8 was slightly higher than control samples. Our results were in agreement with Mihoubi *et al.* Erkaya-Kotan reported that protein of samples containing seeds were between 18.11 and 20.67 during 21-day storage. The results by Erkaya-Kotan were lower than those of our results [23-25].

Table 2. Chemical compounds in watermelon seed flour and watermelon rind (grams per 100 grams)

Moisture(%)	Ash(%)	Protein(%)	Fat(%)	Composition
±0/04^{a}6/73	±0/04^{a}2/85	± 0/08^{a}20/48	±0/06^{b}5/46	Watermelon seeds
± 0/03^{a}6/60	±0/06^{a}2/73	±0/08^{b} 25/69	±0/02^{a}1/45	Watermelon peel

* The numbers are the average of three numbers ± standard deviation.
Different letters in each column indicate significant differences.

Chemical compositions of burger samples

No significant difference was observed for the fat in the control sample and the 4% watermelon peel powder sample, but the 4% watermelon seed powder sample had a significant difference compared with the two mentioned cases. In the 8% samples, the sample of watermelon peel powder showed a significant difference compared with the sample of 8% watermelon seed powder and 4% samples and the control, and it was found that there was a significant increase in the amount of fat. However, no significant difference was seen in the watermelon seed powder sample with 4% and control samples. Regarding the 12% samples, we should say that both the 12% samples had a significant increase with all the 4% samples and the control, as well as the watermelon seed powder sample, but this difference was not significant with the watermelon peel powder sample. There was no significant difference in moisture content in any treatments. The amount of protein in all treatments of watermelon seed powder had a significant difference and this significant difference was further observed for the samples of watermelon peel powder. Besides in all the samples, with the increase in the replacement percentage, the protein increased. The control sample had the highest amount of ash, which was not significantly different from 4% watermelon peel powder, but it was significantly different from other cases. Two samples of watermelon seed powder and 4% watermelon peel powder had no significant difference. This lack of significant difference was further observed in 8% samples. Although in 12%

samples, watermelon peel powder was significantly more than watermelon seed powder. The pH of the control sample was significantly lower than all the samples. In both 4% samples, the pH was higher than the control, but no significant difference was observed between watermelon seeds and watermelon peel powder. 8% watermelon peel powder was not significantly different from two 4% samples, but it was significantly lower than 8% watermelon powder. 8% watermelon powder was not significantly different from 12% watermelon peel powder, although 8% watermelon powder was significantly higher than other treatments except 12% watermelon powder.

Burger cooking features

On average, samples containing watermelon peel seed flour had the lowest percentage of diameter reduction (13.82), thickness increase (16.106) and shrinkage (14.05). Based on the comparison of average data, the highest decrease in diameter, increase in thickness and percentage of shrinkage was related to the control sample and the lowest amount of decrease in diameter, increase in thickness, and percentage of shrinkage was related to the samples containing 12% of watermelon seed flour and watermelon peel. The highest rate of yield was found in 12% samples, which were significantly higher than other samples. The stiffness of 12% samples was significantly higher than 4% and control, but it was not significantly different from 8%. The amount of gum in 12% samples was significantly higher than 4% and control, but it was not significantly different from 8%. The amount of chewability in 12% samples was significantly higher than 4% and control, but it was not significantly different from 8%. The control burger had the highest score (4.8) and the burgers containing 12% watermelon seed flour had the lowest color score (2.7) compared with the control sample. No significant difference was observed in the substitution level of 4% of watermelon seed flour and watermelon peel compared to the control sample. The highest texture sensory score (4.8) was related to the control sample and the lowest score was related to the samples containing 12% watermelon seed flour and watermelon peel (3.4 and 3.6, respectively). There was no significant difference in the replacement level of 4% of watermelon seed flour and watermelon peel compared with the control sample. The highest score was related to the control burger (4.9) and the lowest score was related to the samples containing 12% watermelon seed flour and watermelon peel (3.2 and 3.4, respectively). Based on the comparison of the average data, no significant difference in the taste of the samples was observed at the level of 4% replacement of watermelon seed flour and watermelon peel compared to the control sample. But with the increase of substitution level, the taste score of the samples decreased significantly. The addition of watermelon seed flour and watermelon peel was evaluated significantly on the overall acceptance of burger samples containing legume seed flour compared with the control sample ($p<0.05$). With the increase in the substitution level of watermelon seed flour and watermelon peel in burgers, the overall acceptance score of burger samples containing leguminous seed flour decreased and this decrease was significant.

4. Discussion and conclusion

Conclusion

The results of the present research showed that the use of watermelon peel powder as a source of dietary fiber and watermelon seed powder in burger as a meat product can be used in the

formulation of premium burger. Therefore, the new products with significant nutritional value, properties with an acceptable texture, and organoleptic properties can be obtained. Using watermelon seed flour and watermelon rind in the premium burger formulation, it can lead to a significant decrease in the amount of protein and fat in the burger samples also reduced its ash content. In addition, it had no significant effect on product moisture. Furthermore, the results of analysis of variance showed that the amount of protein and fat of burger treated with both types of seed flour (watermelon and watermelon rind) did not differ significantly. The comparison of average results of data showed that by adding watermelon seed flour and watermelon peel the hardness was significantly increased. However, chewability and gumminess of the samples had no significant effect on adhesion and elasticity. Another point is that any significant effect was observed between the type of flour added in any of the texture parameters. The results of variance analysis showed that by adding watermelon seed flour and watermelon rind, it can led to significantly reduce the percentage of cooking shrinkage, reduced diameter, and increased thickness of the product compared to the control sample. Likewise, at the level of 12%, it caused an increase in the cooking loss of the product. Based on the results of analysis of variance, a significant difference was observed between the decrease in diameter, increase in thickness and percentage of shrinkage of the samples containing watermelon seed flour and watermelon peel. Therefore, the samples containing watermelon rind seed flour had a decrease in diameter, increased thickness and less shrinkage than the samples containing watermelon seed flour. The results of comparing the data showed that by increasing the substitution level, except for the appearance, the score of sensory properties was decreased significantly. According to the results of data analysis, the effect of adding watermelon seed flour and watermelon peel on the burger samples caused an increase in pH compared to the control sample, and this increase was considered significant. Moreover, based on the variance analysis results, a significant difference was observed between the pH of the samples containing watermelon seed flour and watermelon peel so that the samples containing watermelon peel seed flour had a higher pH than the samples containing watermelon seed flour, the watermelon seed flour sample showed better characteristics than the control.

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