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Use of Fresh Pumpkin Fruits for Producing Chicken Sausage Suggests Functional Properties

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Abstract

Pumpkin has particular health properties for patients suffering from chronic diseases as it is considered an excellent and low-cost source of phytochemicals, antioxidant properties, vitamins and minerals, anti-inflammatory properties, and low in calories. This study aimed to fortify chicken sausage with various ratios (15, 30, and 45%) of fresh pumpkin pulp to prevent lipid oxidation during cold storage. Sensory evaluation indicated that the sample fortified with 30% pumpkin is the most favorite and nearest to the control sample. It improved taste and texture as compared to other treatments. Its moisture contents were higher than that of the control group, leading to minimizing the caloric value (25%). Seventeen amino acids were found that were similar to the control sample. Still, the ratio between total essential amino acids and total amino acids in fortified samples was 1.04-fold higher compared to the control sample. A similar trend was also detected when the ratio between saturated and unsaturated fatty acids was calculated. Results showed that this new product has functional, healthy properties for patients suffering from chronic diseases.

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Introduction

Chicken is one of the white meats characterized by its lower iron content compared with red meats (beef and lamb). The popularity of poultry meat is higher because of its high nutritional value and economic characteristics. Also, it is low in saturated fats, easily be enriched with several essential nutrients, and is frequently more affordable than other meats. Chicken meat supplies high-quality protein (around 20 g/100g of skinned raw meat), and its consumption is good for health because it has a relatively high level of unsaturated (mainly polyunsaturated) fatty acids.[1,2]

World Cancer Research Fund reported that eating high amounts (more than 500g weekly) of red meats, especially processed meat, could lead to health problems, not chicken meat. Many of these processed meat products lack minimum levels of dietary fiber. Diets containing high amounts of fat and sugar are associated with chronic diseases such as colon cancer, cardiovascular diseases, and obesity.[3,4,29]

In developing Countries (such as Jordan), the rapid urbanization, globalization, industrialization and increasing participation of women in the workforce caused a rapid inclination toward processed and/or fast foods, many of which contain meat products. However, meat products can be made healthier by the addition of beneficial ingredients or by eliminating harmful components.[5] Many poultry-based products are available in the market as refrigerated, frozen, marinated, and comminuted ones.[6]

Fruits and vegetables are the most important source of phytochemicals that affect human health, as reported by Rimm *et al*.,[7] Rissamen *et al*.,[8] Foster,[9] and Singla *et al*.[34] Many phytochemicals act as antioxidants that stabilize free radicals generated in the human body either naturally or from the surrounding environment. So, fruits and vegetables are considered functional foods and have been widely used worldwide. Antioxidants, including flavonoids, phenolic compounds, and phytoestrogens, are used to treat cancer, hypertension, cardiovascular diseases, renal disorders, and diabetes.[10,11. 36,38,42]

Pumpkin is a healthy and nutritious vegetable. That is native to North America, and the Middle East. The name "pumpkin" is derived from the Greek word “pepon” meaning “large melon”, then "pepon" was changed to "pompon" by the French. Recently, the English changed "pompon" to "pumpion".[12]

Pumpkin is regarded as an excellent and low-cost source of carotenoids and pectin. It is also a rich source of functional food components.[13,37.39] Despite its health benefits, many people do not consume it regularly. Fortified foods with antioxidants are the best option for public health concerns.[14,15] Functional ingredients from vegetable and animal sources are used to achieve different functional foods.[43,44] The main attributes of functional ingredients are water-holding capacity, fat-binding properties (ability to retain water and oil), and texture modulation (increase in meat tenderness). Moreover, water reduces the product formulation cost as adding water to meat increases its processing yield.

This study was conducted to evaluate chicken sausages fortified with various percentages of fresh pumpkin pulp to be used for preventing lipid oxidation during cold storage. In addition, it aims to evaluate the nutritional value, chemical, and organoleptic properties of newly developed sausage after being fortified with fresh pumpkin pulp.

Materials and Methods

Materials

The fresh chicken meat was purchased from the local markets of Jordan including the governorates of Amman, Al-Karak, and Irbid, and transported to Lab within one hour in an ice box. The chicken was minced using a meat mincer. Natural sheep hank was used for stuffing and making sausage—fresh pumpkin fruit (*Cucurbita pepo* L). Seeds were removed from pumpkin fruit, peeled, then cut into small pieces and minced by a meat mincer. The High-performance liquid chromatography-10AVP, Shimadzu, Japan was used to detect fatty acid profiles.[41]

Treatments

The chicken sausage was processed according to the method described by Zaki.[16] The ingredients listed in Table 1 were used to prepare the emulsion of sausage.

Table 1: The formula of chicken sausage fortified with different levels of fresh minced pumpkin pulp

Ingredient (g)	Treatments			
	C_0	S_1	S_2	S_3
Chicken meat	1000	850	700	550
Minced fresh pumpkin	0 (0%)	150 (15%)	300 (30%)	450 (45%)
Starch	30	30	30	30
Garlic	15	15	15	15
Onion	15	15	15	15
Sodium chloride	23	23	23	23
Spices mixture*	12	12	12	12

* Spices mixture used in chicken sausage formula include Black pepper, Red pepper, Cinnamon, Allspice, Clove, Coriander, and Ginger at 30 %, 10%, 15%, 15%, 10%, 10%, and 10%, respectively.

Methods

Proximate Composition

Moisture, protein, ash, and fiber were determined using the official methods of AOAC Methods 925.10, 65.17, 974.24, and 99 2.16, respectively.[17] Total carbohydrates were calculated according to the following equation:

Total carbohydrates = 100 - (% moisture + % protein + % fat + % ash + % fiber).

Fat content was determined using the method of Bligh and Dyer.[18]

Tbars Test

The thiobarbituric acid reactive substances test (TBARS) was performed using the method of Cheah and Abu Hasim 19. TBA value was expressed as O.D at 538 nm.

Identification of Fatty Acids Profile

According to Luddy *et al.*,[20] the fatty acids composition of chicken sausage lipid was released as methyl esters using gas chromatography (Perkin Elmer Auto System XL) with a capillary column containing silica ZB – Wax (60m × 0.32 mm) and equipped with flame ionization detector. The temperature of the oven was initially kept at 50°C and programmed from 50 to 220°C for 2 min at a rate held at 50°C to 4°C /min. The injector temperature was 230°C, the detector temperature was 250°C, and the carrier gas was helium with a 1 mL/min flow rate. Fatty acid methyl esters were recognized and quantified by comparing their retention time with authentic standards.

Analysis of Amino Acids

Amino Acids Analyzer was used to detect and quantify the amino acids in chicken sausage samples.[40]

Caloric Value

The total calories (Kcal/100g) of the uncooked chicken sausage were calculated as described by Mansour and Khalil.[5]

Sensory Evaluation

Sausage samples were roasted for 15 min using an electric oven and then served to ten panelists to evaluate various suggested treatments and scored their quality attributes (taste, texture, juiciness, and overall acceptability) as described by the American Meat Science Association (A.M.S.A.).[21,32]

Statistical Analysis

The obtained data were subjected to a two-way analysis of variance (ANOVA) at 0.05 level of significance.[22]

Results and Discussion

Proximate Composition of Used Materials

Table 2 and Figures 1 and 2 show that pumpkin fruit possessed high moisture content (94.01%), protein content (1.98%), fat (0.07), ash (0.32), and fibers (1.36%). Fat contents in pumpkin pulp were lower (0.07%) than that of chicken meat (14.0%). A similar pattern was noticed in the case of protein, ash, and carbohydrate content, meanwhile, fiber contents showed a reversible pattern; i.e. pumpkin pulp had 6.8-fold higher fiber contents than that of chicken meat.

Table: 2 Proximate chemical composition % of materials used for making supplemented chicken sausage

Component*	Chicken meat	Pumpkin pulp
Moisture	57.90 a	94.01 b
Protein	19.98 a	1.98 b
Fat	14.00 a	0.07 b
Ash	1.30 a	0.32 b
Fibers	0.20 a	1.36 b
Carbohydrates**	6.62 a	2.26 b

*% on a wet weight basis.
** Calculated by difference.
a,b: Means in columns followed with the same letter are not significantly different using Least Significant Differences at a 95% confidence level.

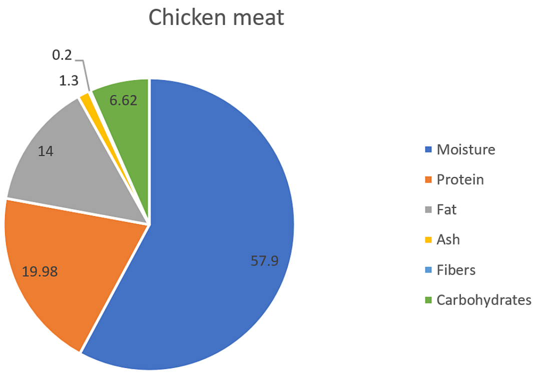

Fig. 1: Percentage of the proximate chemical composition of chicken meat (on a wet weight basis)

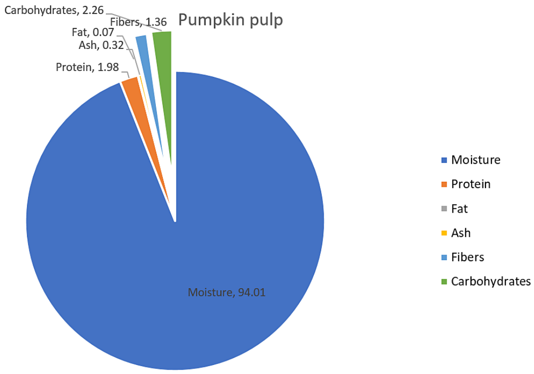

Fig. 2: Percentage of the proximate chemical composition of Pumpkin pulp (on a wet weight basis)

Sensory Evaluation of Suggested Treatments

Taste, texture, juiciness and overall acceptability of suggested chicken sausage treatments (i.e. supplemented with 0, 15, 30, and 45% fresh pumpkin pulp) are the main sensory evaluated parameters for choosing the best one (Table 3). It is observed that S_2 (30% fresh pumpkin pulp) was the best sample. It possessed the highest mean scores for taste (8.50) and texture (8.45) compared with the control sample (8.30), whereas juiciness and overall acceptability had the lowest mean scores (8.65 and 8.00, respectively) compared with the control sample (9.00 and 8.20, respectively). Results showed that the S_2 treatment had the highest score for taste and texture therefore; the S_2 treatment was selected for carrying out this study.

Proximate Composition and Caloric Value of Chosen Treatment

Fig. 3 and 4 show the proximate composition of the S_2 treatment (supplemented with 30% of fresh pumpkin pulp). The caloric values of the treated and control sample were 176 and 233 kcal/100g, respectively. Supplementation of 30% fresh pumpkin pulp minimized the total calories by 25% which denotes the benefits of such fortified product for diabetic patients.[23-28]

Table 3: Mean scores of sensory parameters of various chicken sausages supplemented with fresh pumpkin pulp

Sample	Taste ± SE	Texture ± SE	Juiciness ± SE	Overall acceptability ± SE
C0	8.30a ± 0.21	8.30a ± 0.23	9.00a ± 0.14	8.20a ± 0.29
S1	8.25a ± 0.20	7.95a ± 0.19	8.00b ± 0.23	7.50a ± 0.30
S2	8.50a ± 0.17	8.45a ± 0.21	8.65ab ± 0.23	8.00a ± 0.27
S3	5.50b ± 0.27	5.05b ± 0.28	4.80c ± 0.35	4.64b ± 0.38

*Means in columns followed with the same letter are not significantly different using Least Significant Differences at a 95% confidence level.

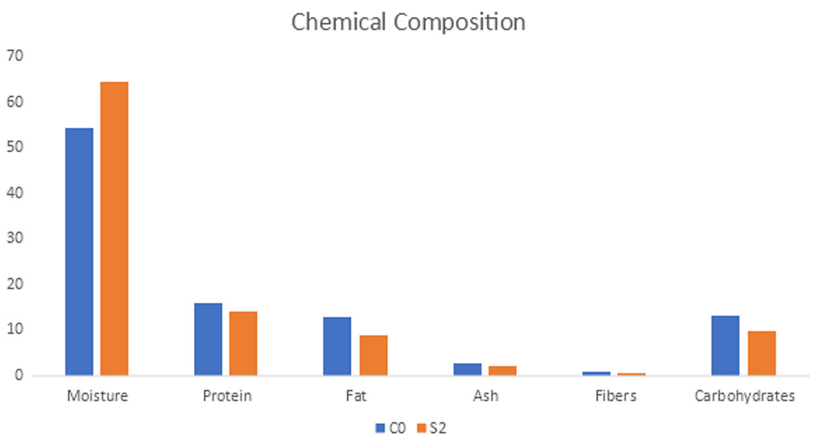

Fig. 3: Proximate chemical composition % of chosen supplemented sausage treatment. Means in columns for each chemical composition with the same letter are not significantly different using a t-test at a 95 % of confidence level

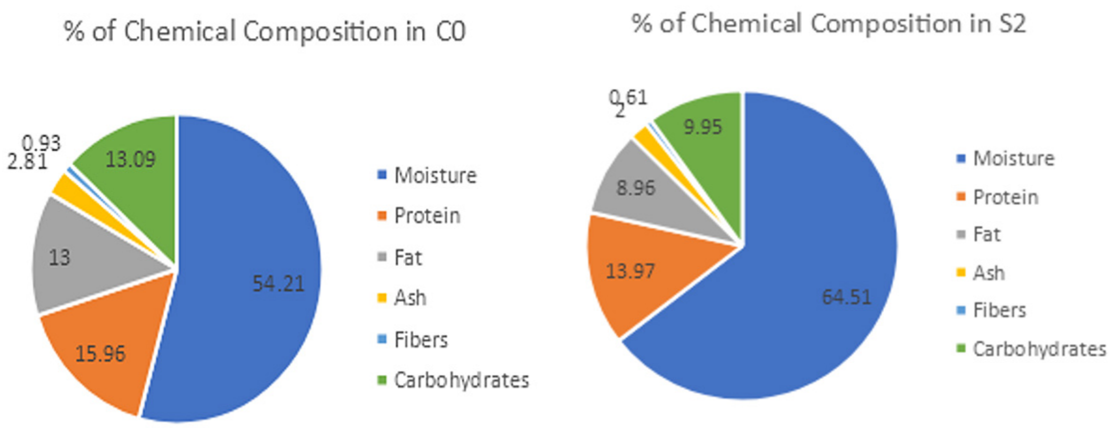

Fig. 4: Percentage of chemical composition in both C0 and S2

Amino Acids Pattern of Chosen Fortified Chicken Sausage Treatment

Table 4 indicates the values of amino acids of the chicken sausage sample supplemented with 30% fresh pumpkin pulp. Seventeen amino acids were detected, ranging between 0.19% (cystine) to 4.01% (glutamic acid), similar to that found in control one, which possessed a corresponding value of 0.29 and 6.31%. Glutamic acid appeared as the major one either in the treated or untreated sample; it was 6.31 and 4.01% in control and fortified samples, respectively. It means that fortification treatment with 30% fresh pumpkin pulp minimized such amino acids by 1.6 fold. A similar trend was also recorded in other detected amino acids except in the case of histidine which had a contradicted trend; i.e. elevated by 1.4 fold as a result of the fortification process. This result is due to chicken meat substitution with 30% fresh pumpkin pulp which possesses lower amino acids.[31,32] From the same table, it could be easily calculated TAA= total amino acids (TAA), TEAA = total essential amino acids (TEAA), and the related TEAA/TAA ratio. These values were 24.34, 10.55 and 43.34% for the treated sample, respectively, while the corresponding values for untreated one were 37.30, 15.53, and 41.63. Such findings indicated that the TEAA/TAA of the fortified sample was higher by 1.04-fold than that of the unfortified one. This result goes in parallel with that of Zhang *et al*.[27]

Table 4: Identified amino acids % of chicken sausage fortified with 30% fresh pumpkin pulp

Amino acid (A.A.)%	Control sample ± SE	Fortified sample ± SE
Aspartic acid	3.50**b ± 0.23	2.30a ± 0.23
Glutamic acid	6.31a ± 0.23	4.01b ± 0.07
Threonine*	1.78a ± 0.07	0.90b ± 0.23
Serine	1.30a ± 0.14	0.71b ± 0.02
Glycine	2.50a ± 0.23	1.73a ± 0.03
Alanine	3.02a ± 0.23	1.59b ± 0.23
Valine*	1.91a ± 0.02	1.12b ± 0.02
Isoleucine*	1.55a ± 0.02	0.98b ± 0.03
Leucine *	2.50a ± 0.07	1.70b ± 0.12
Tyrosin	1.33a ± 0.14	0.76b ± 0.07
phenylalanine*	1.60a ± 0.03	1.32a ± 0.14
Tryptophan *	1.20a±0.10	0.90b±0.11
Histidine*	1.39a ± 0.03	1.94a ± 0.23
lysine*	2.61a ± 0.23	1.40b ± 0.02
Arginine	2.42a ± 0.02	1.60a ± 0.32
Proline	1.60a ± 0.07	0.90b ± 0.06
Cystine	0.29a ± 0.02	0.19b ± 0.03
Methionine*	0.49a ± 0.04	0.29b ± 0.02
Total A.A.%	37.30a ± 0.69	24.34b ± 0.58
Total E.A.A%	15.53a ± 0.58	10.55b ± 0.61
Total E.A.A/ Total A.A ratio	41.63a ± 1.15	43.34a ± 0.69

*Essential amino acid (E.A.A.)
**Means in each row with the same letter are not significantly different using a t-test at 95% confidence level

Fatty Acids Profile of Chosen Fortified Chicken Sausage Treatment

Table 5 shows that the major saturated fatty acids (SFA), palmitic acid, and stearic acid, were 21.92% and 5.96% in the fortified sample and 22.01% and 6.17% in the control sample, respectively. Consequently, the total SFA in the treated sample (fortified with 30% of pumpkin pulp) was 1.01 fold lower than that of the control sample owing to its lower fat content. Table 5 reveals that in the treated sample, the unsaturated fatty acids (USFA), oleic (38.30%), linoleic (25.01%), and palmitoleic (4.11%) were in descending order as compared to the control sample which showed the value 37.88% for oleic, 24.92% for linoleic and 4.09% for palmitoleic. The total USFA was 1.01-fold higher in fortified samples as compared to the control. In addition, the ratio of SFA/USFA was also increased by 1.01-fold.

Table 4: Saturated fatty acids (SFA) and unsaturated fatty acids (USFA) percentages of chicken sausage sample fortified with 30% of fresh pumpkin pulp

Fatty acid%	Control sample ± SE	Fortified sample ± SE
	Saturated fatty acids (SFA)	
C14:0	0.52a ± 0.03	0.40b ± 0.02
C16:0	22.01a ± 0.04	21.92a ± 0.25
C17:0	0.31a ± 0.02	0.19b ± 0.03
C18:0	6.17a ± 0.03	5.96a ± 0.52
Total SFA	29.01a ± 0.58	28.47a ± 0.40
	Unsaturated fatty acids (USFA)	
C16:1	4.09a ± 0.05	4.11a ± 0.06
C18:1	37.88a ± 0.07	38.30a ± 0.17
C18:2	24.92a ± 0.35	25.01a ± 0.34
C18:3	1.59a ± 0.17	1.58a ± 0.02
C18:4	0.12a ± 0.01	0.13a ± 0.02
C20:1	0.25a ± 0.03	0.23a ± 0.03
C20:2	0.18a ± 0.01	0.10b ± 0.02
C20:3	0.08a ± 0.01	0.09a ± 0.02
C20:4	0.26a ± 0.02	0.24a ± 0.02
Total USFA	69.37a ± 1.17	69.79a ± 0.12
SFA/USFA	40.48b ± 0.01	40.79a ± 0.06

*Means in each row with the same letter are not significantly different using a t-test at a 95% confidence level.

Results showed that the new chicken products may be considered a good functional food suitable for patients suffering from heart diseases, diabetes, and obesity.[31,32]

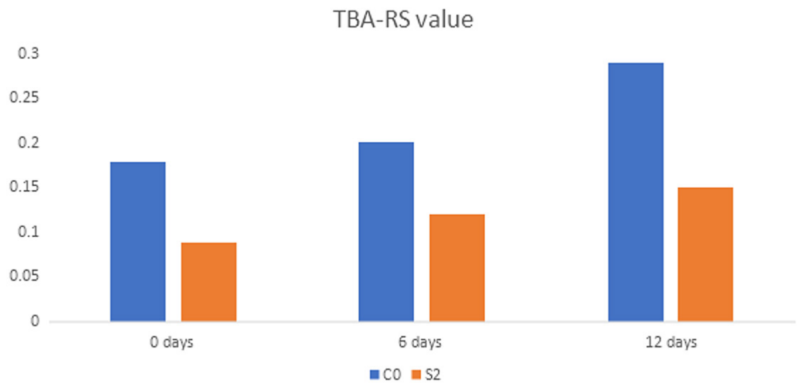

Fig.5: TBARS value (as O.D at 538nm) of fortified chicken sausage with 30% fresh pumpkin pulp during refrigerated storage at 4°C /12 day. Means in columns for each chemical composition with the same letter are not significantly different using a t-test at 95 % of confidence level

Tba-Rs of Suggested Chicken Product

TBA-RS test was carried out to evaluate the quality of chicken sausage fortified with fresh pumpkin pulp during refrigeration storage at 4°C /12 day. Figure 5 shows that the O.D of the control sample increased faster than that of the treated sample throughout cold storage for 12 days. It means that pumpkin pulp had an antioxidant activity which delayed the lipid oxidation process of fortified sausages.[33]

Conclusions

The current investigation focused on exploring the potential utilization of fresh pumpkins as an ingredient in refrigerated chicken sausages. Through the incorporation of 30% fresh pumpkin pulp, notable enhancements in resistance to lipid oxidation were observed throughout the entire 12-day refrigerated storage period at 4°C. Our study findings revealed the significant antioxidant activity of pumpkin pulp, effectively inhibiting the lipid oxidation process within the fortified sausages. As a result, this novel ingredient exhibited the capacity to extend the shelf life of the sausage products. Additionally, our results indicate the potential of the newly developed chicken sausages to serve as functional food, particularly suited for individuals with diverse chronic diseases. Consequently, the proposed approach holds promise in terms of reducing final product costs and providing substantial health benefits to consumers.

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Conflict of Interest

The authors declare no conflict of interest.

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