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Effect of Adding Different Concentrations of Cowpea *Vigna unguiculata* (L.) on Physicochemical and Sensory Properties of Chicken Mortadella

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Abstract: Four chicken mortadella were prepared: C (control), M1, M2 and M3 by addition of 10%, 15%, and 20% of minced cowpea, respectively). The effect of adding minced cowpea on the physical, chemical, microbial, and sensory evaluation of mortadella had been studied. Results revealed that there were significant differences in fat, carbohydrates, and ash percentages in the mortadella. The fat percentage was gradually decreased from 15.13 % in the control group to 11.03 % in M3. Carbohydrate and ash were increased from 3.94, 2.53 % in the control group to 7.14, and 2.76 % in M3 respectively according to the increase of cowpea in the mortadella. Protein and moisture were increased with no significant difference in all mortadella examined. Water holding capacity was increased significantly by adding minced cowpea. Microbial load test revealed that there was an obvious decrease in total bacterial count and Escherichia coli with an increase of cowpea in the mortadella. For sensory evaluation there were significant differences in some characteristics between control and other groups, colour, flavour, and taste decreased according to the increase of cowpea in the mortadella formulations, the decrease was high in the M3 group and low in M1 and M2 groups with some similarity to the control group. The texture was improved by adding more minced cowpea to the mortadella particularly in the M3 group. Accordingly, the effect of these quality properties was reflected in the degree of general acceptance of the mortadella formulations.

Keywords: Chicken, Cowpea and Sensory Evaluation, Mortadella.

Introduction

Mortadella is one of the meat products preferred by most consumers because of its great taste and high nutritional value (Pirak, 2018). Mortadella consumption has been limited in most countries (developing nations) due to the high cost of meat. Recently, consumer awareness and lifestyle change have increased the demand for healthy foods with high nutritional value, especially high protein content, low- fat, low calorie, and low - cost, (Lim *et al*., 2010).

Different plant proteins used in meat processing include pea, cowpea, chickpea, soybean, and other legumes. It is usually rich in proteins and carbohydrates with high starch content. The protein contents of most legumes are between 17-30%. Apart from their nutritional properties, the proteins also possess functional properties that play an important role in food formulation and processing. Examples of such functional properties include water and fat binding capacity, solubility, and foaming (Boye *et al*.,

2010). Cowpea (*Vigna unguiculata*) is an important multipurpose legume with high nutritional qualities. It is a good source of complex carbohydrates, proteins, dietary fibers (both insoluble and soluble), vitamins, especially of the B-complex, and minerals such as iron and calcium (Gonçalves *et al*., 2016).

Proteins from plant sources are widely used as a partial substitute for animal proteins in meat products due to their low cost, fat, and cholesterol content. They also improve some chemical and physical properties of meat products (Akwetey & Knipe, 2012).

Adding legumes to meat products is one of the convenient ways to reduce production costs and gain more acceptance for their nutritional and organoleptic properties (Mcwatters, 1990). Cowpea is a legume that is widely used as a low-cost plant protein, as well as being high in carbohydrates. It can be used in meat products that improve sensory and nutritional properties (Phillips *et al*., 2003). The plant proteins are of great importance for their high energy presence and their physical and chemical functions because they improve water holding capacity, reduce cooking loss and make the product have an improved texture (Savadkoohi *et al*., 2014). Unatrakarn (2014) used plant protein sources in the manufacture of meat products because they have high nutritional value, health benefits, improved product characteristics, and low cost.

Teye *et al*. (2012) used cowpea in beef burger processing. Akwetey *et al*. (2014) said that adding cowpea powder to the meat bread improves some subjective traits and physical properties like water holding capacity and weight loss. Sharima-Abdullah *et al*. (2018) use chickpea powder in manufacturing chicken sausages

Due to the high costs of meat and its health effects, it was necessary to investigate the use of cowpeas in the improvement of meat, physical, microbial, and sensory properties of chicken mortadella.

Materials & Methods

Materials

Cowpea seeds (*Vigna unguiculata*), chicken chests frozen, and other ingredients were obtained from local companies in Basrah, Iraq. Cowpea soaked in water for 6 hours and, after peel removal, boiled in hot water for 10 minutes, and mince with an electric mincer. Chicken chests were cut into small pieces and mince with a meat grinder.

Preparation of chicken mortadella

The mortadella has been prepared was carried out by following the method described by Prestes *et al*. (2015) with some modifications. Four types of chicken mortadella products with different proportions of cowpea and minced meat were prepared according to table (1), the manufacturing process was as follows: Initially, salt was added to the minced chicken meat and stored at 4°C for 24 hours, after which the ingredients were added in tables (1 and 2) to the meat gradually and mix well until homogeneous, the mixture should be in the form of a thick liquid. The mixtures are packed in metal cans 250 ml, the mortadella was cooked in a water bath at 80°C until the internal temperature reached 72°C (about 2 hours); the products were cooled using shower for 30 min to harden before weighing and vacuum packing. Mortadella were stored under refrigeration (4°C) for (one day) until analysis.

Table (1): Formulations used in chicken mortadella processing.

Component	Control	M1	M2	M3
Chicken meat	80	70	65	60
Cowpea	0	10	15	20
Oil	15	15	15	15
Starch	5	5	5	5

Table (2): Additives of chicken mortadella.

Additive	Percentage
Salt	2.00
White pepper	0.25
Crushed garlic	0.50
Ginger	0.12
Iced water	20.0
Nutmeg	0.12
Red dye	0.05
Sodium pyrophosphate	0.50
Ascorbic acid	0.50

Chemical composition of chicken mortadella

The chemical composition (moisture, protein, ash, and fat contents) of chicken mortadella was determined by AOAC (2016). Moisture content was estimated by oven drying at 105 °C to stability weight. Protein was estimated by the method of Semi-micro Kjeldahl. The total nitrogen was estimated and multiplied by the protein conversion factor (6.25). Fat content was measured by the Soxhlet method using organic solvent petroleum ether with a boiling point range between 40-60 °C. Ash was determined via burn the Mortadella sample in the Muffle furnace at 550 °C to get the white ash. As for carbohydrates, it was calculated from the difference between the number 100 and the sum of moisture, protein, fat, and ash.

Water- holding capacity

Water holding capacity was determined by the method described by Troy *et al*. (1999), for which 20 g mortadella sample was mixed using a glass rod with 30 ml of a 0.6 molars sodium chloride solution, which were stored under refrigeration 5° for 15 minutes. Afterwards, the sample was placed in a centrifuge at 3000 cycle minute^{-1} for 15 minutes. Finally, the precipitate was measured and subtracted from the added solution. The water holding capacity was expressed as a percentage as described in equation:-

$$WHC\% = [(final\ weight - initial\ weight) \backslash initial\ weight] \times 100$$

Microbial tests

Microbial load in chicken mortadella, chicken and cowpea were assessed, which includes the identification of total counts of bacteria, *E. coli*, *Salmonella* ssp., *Staphylococcus aureus.* Determination was done according to the method of Andrews (1992).

Sensory evaluation

Sensory evaluation for texture, colour, taste, flavor, and overall acceptability for the cooked formulated mortadella using a 9-point Hedonic scale (1 dislike extremely, 5 neither like nor dislike and 9 like extremely) for the products by the taste panel was used as described by Igene *et al*. (1979) with some modifications were carried out in order to determine the consumer acceptability for the product. Mortadella was sliced (0.5 cm thickness) and placed in a closed container until analysis. The samples was assessed by 10 panelists chosen from the Department of Food Sciences, College of Agriculture, University of Basrah.

Statistical analysis

The data generated from the study were subjected to a Completely Random Design (C.R.D.) with factorial experiment. The data were analyzed statistically using the statistical program SPSS ver. 21. The comparison among means was conducted using less significant difference (L.S.D.) at 0.05 level.

Results & Discussions

Chemical composition of chicken mortadella

Table (3) shows the percentage composition for moisture, ash carbohydrate, protein, and fat of chicken mortadella formulations. There was significant effect ($p > 0.05$) among all formulations. Moisture percentage increased significantly ($p > 0.05$) with increased use of minced cowpea in the mortadella formulations from 61.94% (control) to 62.44% (M_3). This indicates that the cowpea had the ability to retain water (Phillips *et al*., 2003). This result was consistent with (Akwetey *et al*., 2014) who observed that moisture content increased significantly ($p > 0.05$) with increasing levels of Whole cowpea flour in meatloaf formulations. The protein content also increased significantly ($p < 0.05$) from 16.46 (control) to 16.63% (M_3) in mortadella formulations. Protein contents of whole cowpea ranged from20 to 30% (Vasconcelos *et al.*, 2010; Avanza *et al.*, 2013). The ash content also recorded increase significantly ($p>0.05$) in mortadella formulations. This may be due to the increase of ash content in cowpea. The lipids content decreased significantly ($p > 0.05$) with addition of minced cowpea in mortadella formulations ranged from 11.03% in M3 to 15.13% in control, this is due to the low-fat contents in cowpea (El-Niely, 2007).The carbohydrates contents in formulations of chicken mortadella were increased significantly ($p > 0.05$) from 3.94% in the control to 7.14% in M3, with increase of minced cowpea due to the high carbohydrate content in cowpea when compared with chicken (Fernandez-Gines *et al*., 2003).

Water Holding Capacity (WHC)

Fig. (1) shows that the water holding capacity (WHC) of chicken mortadella formulations, (control, M1, M2, and M3) were (18.55, 19.67, 21.17, and 23.42%) respectively. There were highly significant differences ($p > 0.05$) among the various levels of adding minced cowpea compared to control. The data showed that the addition of minced cowpea increased the WHC value. This gives the impression that cowpea increased the ability of water retention and the tenderness of the product. This result indicates the positive role of cowpea in increasing the WHC in processed mortadella, cowpea contains abundance of polysaccharides and were found to help in retaining water molecules in mortadella system. Hence, cowpea has a good water holding capacity and emulsifying (Akwetey *et al*., 2014).

Table (3): Chemical composition of chicken mortadella.

Parameters (%)	Moisture	Protein	Lipid	Ash	Carbohydrate
Control	61.94±0.21^{c}	16.46±0.20^{c}	15.13±0.02^{a}	2.53±0.12^{d}	3.94±0.32^{d}
M1	62.17±0.17^{b}	16.55±0.12^{b}	13.44±0.16^{b}	2.64±0.11^{c}	5.20±0.22^{c}
M2	62.34±0.14^{a}	16.62±0.13^{a}	12.23±0.21^{c}	2.72±0.13^{b}	6.09±0.12^{b}
M3	62.44±0.11^{a}	16.63±0.13^{a}	11.03±0.02^{d}	2.76±0.13^{a}	7.14±0.11^{a}
L.S.D.	0.12±0.01	0.02±0.008	1.50±0.21	0.03±0.01	1.03±0.21

- Means in same column with different lowercase letters indicate significant difference (P<0.05) between Chemical composition of chicken mortadella

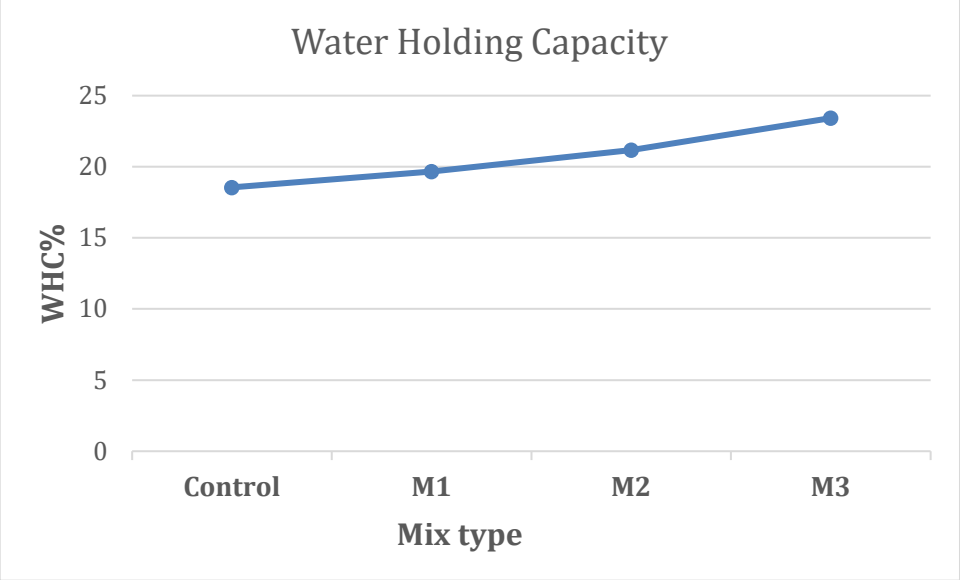

Fig. (1): WHC of chicken mortadella.

Microbial Analysis

Table (4) shows that the Microbial Analysis of chicken mortadella formulations before canning and the raw materials used in the preparation of mortadella. There were highly significant differences (P< 0.05) in total viable count and *E.coli* among the samples. The total viable count (CFU.g^{-1}) in chicken meat and minced cowpea were 3.4 ×10^{6} and 2.8 × 10^{3} respectively, while for chicken mortadella formulations for control, M_1, M_2 and M_3 were 7.2×10^{5}, 4.6×10^{5}, 2.7×10^{5} and 1.8×10^{5} respectively. The *E. coli* count (CFU.g^{-1}) observed in Chicken meat was 2.3x10^{2} followed by zero in minced cowpea, 4.7x10^{2} in control, 2.5x10^{2} in M_1, 1.4x10^{2} in M_2, and 1.1x10^{2} in M_3. The results also illustrated that the *Salmonella* and in all samples was absent. The higher total viable count and *E. coli* was found to be in chicken meat, while minced cowpea was showed the lower. This is a normal because the meat is a good media for bacterial growth, therefore it affects the bacterial load in mortadella processed (M_1, M_2, and M_3) positively, and there was an obvious decrease in the bacterial load with the increase in minced cowpea added when compared with the control group. The reason for the low total viable count and *E. coli* in mortadella processed may be due to plant sources that include a high level of antimicrobial compounds (Alahakoon *et al*., 2014).

Table (4): Microbial Analysis for mortadella.

Variables	**Total count** CFU.g^{-1}	***E. coli*** CFU.g^{-1}	***Salmonella*** CFU.g^{-1}	***Staphylococcus*** CFU.g-1
Control	$7.2 \times 10^{5\ b}$	$4.7 \times 10^{2\ a}$	0	0
M1	$4.6 \times 10^{5\ c}$	$2.5 \times 10^{2\ b}$	0	0
M2	$2.7 \times 10^{5\ d}$	$1.4 \times 10^{2\ c}$	0	0
M3	$1.8 \times 10^{5\ e}$	$1.1 \times 10^{2\ d}$	0	0
Minced cowpea	$2.8 \times 10^{5\ a}$	0	0	0
Chicken breast	$3.4 \times 10^{5\ f}$	$2.3 \times 10^{2\ e}$	0	0
L.S.D.	2.88×10^{2}	1.46×10^{2}	0	0

Means in same column with different lowercase letters indicate significant difference (P<0.05) between Microbial Analysis for mortadella

Sensory evaluation

The results of sensory attributes of chicken mortadella showed that products of all the formulations were acceptable in sensory characteristics (Table 5), but significantly (P< 0.05) differentiated all the sensory evaluation of mortadella. In comparison to control group, there was no change in colour of M1 and M2 with some similarity to the control group, but in the M3 the decline is more obvious than in other mixtures. The flavor is similar to the colour degrees. There was a decline in the degrees of taste with an increase in the percentage of minced cowpea and it is more obvious in M3, while there was a slight decline in M1 and M2 compared to control. The texture was improved by adding cowpea according to its percentage in the formulations when compared with the control group mainly in M3. This effect greed with studies of other authors which indicates that carbohydrates has the ability to retain water or bind water may help improve the texture (Zhao *et al*., 2014). The effect of these properties has been reflected in the general acceptance of mortadella. The decline in sensory evaluation of chicken mortadella with the increase in the percentage of minced cowpea has been accepted in M1 and M2 with 10% and 15% respectively with no

effect of mortadella quality, while M3 with 20% cowpea recorded low acceptance except for texture which improved by the increase of cowpea addition. These results obtained in this study agreed with those reported by Sharima-Abdullah *et al*. (2018) who study the effect of addition different levels of chickpea flour to the chicken sausages.

Table (5): Degrees of sensory evaluation of chicken mortadella.

Property Mixture	**Colour**	**Texture**	**Flavor**	**Taste**	**General Acceptance**
Control	8.6 ± 0.41^{a}	7.8 ± 0.28^{c}	8.4 ± 0.22^{a}	8.8 ± 0.18^{a}	8.7 ± 0.12^{a}
M1	8.3 ± 0.35^{b}	8.0 ± 0.11^{b}	8.5 ± 0.13^{a}	8.2 ± 0.31^{b}	8.3 ± 0.22^{b}
M2	8.3 ± 0.32^{b}	8.1 ± 0.13^{b}	8.2 ± 0.11^{b}	7.8 ± 0.33^{c}	8.2 ± 0.12^{b}
M3	7.9 ± 0.23^{c}	9.2 ± 0.13^{a}	7.2 ± 0.42^{c}	6.6 ± 0.41^{d}	6.8 ± 0.11^{c}
L.S.D.	0.21±0.4	0.52±0.12	0.11±0.01	0.6±0.01	0.33±0.11

Means in same column with different lowercase letters indicate significant difference (P<0.05) between formulations of chicken mortadella and control.

Conclusion

This study demonstrates that the potential of adding 10%-15% of minced cowpea to the formulation of chicken mortadela does not alter the sensory characteristics of the product. In comparison, adding 20% of minced cowpea negatively affected the sensory characteristics of the product except for the quality of texture which evidently improved.

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Conflicts of interest

The authors declare that they have no conflict of interest.

Ethical approval

All ethical guidelines related to poultry breeding and care issued by national and international organizations were implemented in this report.

Contribution of authors

K.H.A.H.: Sample collection, Data collection, and wrote the manuscript.

M.Z.E.: Sample collection, read and revised the manuscript.

H.H.M.A.: Statistical analysis, read and revised the manuscript.

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تأثير اضافة نسب مختلفة من اللوبيا *Vigna unguiculata* على الخواص الفيزيوكيميائية والحسية لمرتديلا الدجاج

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المستخلص: حضرت اربع خلطات من مرتديلا الدجاج ثلاثة منها M1 و M2 و M3 تمت بإضافة نسب مختلفة من اللوبيا المفرومة بتراكيز 10 و 15 و 20 % على التوالي وتركت الخلطة الرابعة بدون اضافة لتكون هي خلطة السيطرة . درس تأثير إضافة اللوبيا المفرومة على الخصائص الكيميائية والفيزيائية والحسية والميكروبية لخلطات المرتديلا. اظهرت النتائج وجود فروق معنوية لخلطات المرتديلا لكل من نسبة الدهن والكربوهيدرات والرماد اذ انخفضت نسبة الدهن تدريجيا مع زيادة نسبة تركيز اللوبيا المفرومة المضافة من 15.13 % في خلطة السيطرة حتى بلغت 11.03% في الخلطة M3 وارتفاع نسبة كل من الكربوهيدرات والرماد من 3.94 و 2.53 % في خلطة السيطرة الى 7.14 و2.76 % في الخلطة M3 على التوالي، في حين سجلت كل من نسبة البروتين والرطوبة زيادة طفيفة لم تؤثر معنويا في جميع الخلطات. أظهرت النتائج ان قابلية حمل الماء ازدادت معنويا مع زيادة نسب إضافة اللوبيا المفرومة. اظهرت نتائج الفحوصات الميكروبية انخفاض واضح في اعداد البكتريا الكلي وبكتريا *E. coli* مع زيادة نسبة اضافة اللوبيا المفرومة الى خلطات المرتديلا مقارنة بخلطة السيطرة . وبينت نتائج التقويم الحسي وجود فروقات معنوية في بعض الصفات الحسية بين خلطة السيطرة وبعض الخلطات الأخرى إذ لوحظ انخفاض في درجات صفة اللون والنكهة والطعم بازدياد نسبة اللوبيا المفرومة المضافة وكان الانخفاض عال في الخلطة M3 بينما كان اقل في الخلطة M1 و M2. وكانت مقاربة لخلطة السيطرة. اما صفة القوام فقد لوحظ ان هذه الصفة تتحسن بإضافة منقوع اللوبيا المفروم ونسبة اضافته الى الخلطات مقارنة بعينة السيطرة وكان واضحا في الخلطة M3. وانعكس تأثير هذه الصفات على درجة القبول العام لخلطات المرتديلا.

الكلمات المفتاحية: لحم الدجاج، اللوبيا، التقييم الحسي، المرتديلا.