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SOME MEAT BY PRODUCTS AS SUBSTITUTE FOR BEEF MEAT IN THE PRODUCTION OF CHEEP MEAT SAUSAGE

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Abstract

To study the effect of partial substitution of some meat by products for beef meat in the production of cheap meat sausages, samples were preparied with replacement of 20, 30 and 50% of beef meat by equal proportions of meat by-products (spleen and lung, 1:1 ratio). There was slight decrease in protein (from 13.30% to 13.14, 13.07 and 12.91% on wet weight basis, respectively). No significant difference was observed between the amounts of amino acids within samples, but there was slight decrease in amino acids by increasing the replacement. The iron content was increased, but zinc content was slightly decreased in sausages samples with replacement. Incorporation of meat by-products in beef sausage formula improved the WHC, plasticity and tenderness, while emulsifhying capacity (E.C.) showed little decrease. Organoleptic evaluation revealed that differences in color, taste, odor, and texture between control and beef-meat by-products sausages were not marked. Therefore, sausages prepared by replacing 50% by 50% of beef meat in recipe with meat by-products (spleen and lung, 1:1 ratio) might be recommended commercially.

INTRODUCTION

Internal organs, such as liver, brain, lung, heart, spleen, kidney, sweet bread and tripe are considered as by-products in many countries. According to the Shorter Oxford Dictionary (Wilson *et al.*, 1981), the term offal is defined as: the parts cut off when dressing the carcass of animal killed for food. Mutkoski and Schurer (1981) reported that these fresh edible meat by-products are rich in protein, vitamins and minerals, most are cheaper than other meat cuts. Edible offals (variety meats or meat organs) such as brain, liver, lung and spleen are among meat by-products and can be considered nutritionally rich as they contain sufficient amounts of high quality animal proteins, minerals and vitamins. Moreover, they are easily digested and their extract promotes the flow of the gastric juice (Rice, 1970). Rogowski (1979). Rogowski (1978) reported that the chemical constituents of the beef lung and spleen were 79.0 and 77.0% water, 16.0 and 18.0% protein, 4.0% fat, and 1.0 and 1.0% ash, respectively. while, El-Moudy (1979) found that the chemical composition of raw beef lung was

78.95% moisture, 20.12% protein, 2.3 fat and 1.32% ash. Seleim (1981), generally concluded that liver, heart, kidney, spleen, tongue and brain organs of beef and buffalo may be considered rich sources of phosphorous, iron, zinc, manganese, potassium and copper, while it may be considered good source of sodium and magnesium in human diet, but they are poor sources of calcium. She also found that spleen of beef contained higher amounts of copper, iron, manganese, magnesium, potassium and phosphorous than the other organs. Schweigert *et al.* (1954) estimated the amounts of amino acids in lung and spleen from beef (as gm/16 g nitrogen), the obtained results were: leucine 8.4 and 8.0; valine 6.0 and 6.2; isoleucine 4.2 and 4.6, methionine 2.0 and 2.11; phenylalanine 4.6 and 4.5; threonine 4.1 and 4.6; arginine 6.1 and 5.9; histidine 2.4 and 2.4; lysine 7.3 and 7.7; tryptophan 1.0 and 1.08, respectiely. The average composition of beef (lean meat) was 74.0% moisture, 20.3% protein, 4.6% fat and 1.1% ash. Amino acids composition of beef meat (as gm/16 g nitrogen) were: isoleucine 5.12, leucine 8.0, lysine 8.0, lysine 9.12, methionine (as gm/16 g nitrogen) were: isoleucine 5.12, leucine 8.0, lysine 9.12, methionine, 2.72, cystine 1.28, phenylalanine 4.48, tyrosine 3.84, threonine 4.64, tryptophan 1.28, valine 5.28, arginine 6.72, histidine 3.68, alanine 6.40, aspartic 9.60, glutamic 17.28, glycine 5.60, proline 5.12 and serine 4.48, Paul and Southgate (1978). In fact, sausages are one of the most popular meat products in the world as well in Egypt. Moher *et al.* (1972) reported that a relatively great proportion of the daily needs of man in energy and lipids are derived from sausages in Germany. Whiting and Jankins (1981) found that the beef frankfurters contained 20.8% protein, 4.6% fat, 73.5% moisture, 134% water holding capcity (WHC), 87.7 ml oil./0.75 gm meat emulsifying capacity (E.C.), 6.85 flavor score and6.08 texture score. Abd El-Aziz (1990) reported that the chemical composition and quality aspects of beef sausages were : 64.41% moisture, 11.46% protein, fat, 20.43% fat, 1.95% ash, 0.05% fiber, 0.70% carbohydrates, 52.6 ml oil/0.75 gm sample (E.C.), 0.39 mg malonadehyde/gm Thiobarbituric acid (TBA) value, 2.93cm^3 WHC, 3.93 cm^2 plasticity, 4.2 kg/cm^2 tenderness, 6.16 mg/100g total volatile (TVN), and scores of color, taste, aroma and texture were: 9, 8, 8 and 8, respectively. Bittel *et al.* (1981b) stated that mechanically separated spleen (MSS) appears to be ideally suited for incorporation into finelly comminuted products and found that the beef and pork frankfurters were produced with 0, 5,10 and 15% of the meat block being MSS. Consumer panelists rated all products acceptable and noticed that shear values decreased with increased MSS. Frankfurters with 5,10 and 15% MSS had 2.2, 3.9 and 4.9 ppm more iron than control (0% MSS), respectively. Also, they concluded that the observed and measured loss in firmness of frankfurters due to increased level of MSS in the formulation is most probably a result of the absence of skeletal muscle protein in

splenic tissue.

The objective of this investigation is to study the effect of partial substitution of some meat by- products for beef meat on the production of cheap meat sausage.

MATERIALS AND METHODS

Material

Fresh beef and meat by-products (spleen and lung) were purchased from a private shop at Giza. Spices (black pepper, cumin, cubeb, nutmeg, cardamom, cloves and garlic) were obtained from local market. Each spice was powdered in laboratory mill. Then a mixture of powdered spieces was prepared as follows: 5.62% black pepper + 11.22% cumin + 22.44% cubeb + 0.22% nutmeg + 2.24% cardamom + 2.24% cloves + 56.06% garlic. Sausage samples were prepared according to the following formula: 67% minced fresh meat + 15% minced fat tissues + 10% ice water + 5% fine dry rusk + 2.25% sodium chloride + 0.01% sodium nitrite + 0.74% spices. Sodium nitrite was dissolved in a small amount of water before being added to the formula. The ingredients were mixed (emulsified) using a laboratory emulsifier for sausages and was carried out for 8-10 minutes. The obtained emulsion was stuffed in previously cleaned and prepared natural mutton casings.

The partial substitution of lean meat was carried out by 10% spleen + 10% lung; 15% spleen + 15% lung; and 25% spleen + 25% lung in prepared samples of sausages.

Analytical methods

The moisture, protein, fat and ash contents were determined according to the methods described in the A.O.A.C. (1984) and the carbohydrates content was calculated, as percentage, by calculating the differenc between one hundred and the sum of the percentages of moisture fat, protein and ash.

Iron (Fe) and zinc (Zn) levels were determined using a Perkin-Elmer 403 atomic absorption spectrophotometer by Perkin-Elmer (1976).

Emulsifying capacity (E.C.) of the tested samples was determined according to the method described by Wee *et al* (1970).

Total volatile nitrogen (TVN) was determined according to the method described by Winton and Winton (1958).

Thiobarbituric acid value (TBA) was determined as described by Pearson (1970).

Water holding capacity (WHC) was determined using the centrifugation method given by Golavin (1969). But plasticity of all samples was measured using the method of Soloviuskaia and Merkodlovia (1958).

The Warrer-Bratzler shear force appartus was used to measure the tenderness as reported by Herring (1976).

Amino acids composition was determined according to the method described by Pellett and Young (1980), but tryptophan was colorimetrically determined in the alkaline hydrolyzate of the samples to be analyzed according to the method of Blauth *et al.* (1963).

The samples, after cooking (by boiling) were subjected to oranoleptic evaluation according to the technique reported by Molander (1960). In this technique, ten trained members of the meat and Fish Technology Laboratory were asked to evaluate organoleptically the color, texture and overall acceptability of the tested samples. Judging scale was as follows: very good 8-9, good 6-7, fair 4-5 and poor 2-3.

Cooking loss of the prepared sausages samples was determined and calculated as described by El-Nemr (1979) which could be summarized as follows: Cooking loss of all samples was determined after boiling in water for 15 minutes and calculated as follows:

$$\% \text{ Cooking loss} = \frac{\text{fresh sample weight - boiled sample weight}}{\text{Fresh sample weight}}$$

RESULTS AND DISCUSSION

It should be noted that due to the high price of animal meat protein in developing countries, including Egypt, another protein source is usually used in human diet. When fresh meat by-products replace a part of meat in sausages, the final product would be of less selling price which might be available to the low income. Utilization of meat by-products in sausages could also improve the quality of the final products.

Data in Table 1 show the chemical composition of beef, lung and spleen meats. It was found that lung and spleen contain higher moisture, ash and carbohydrate contents than beef meat, while proetin and fat contents were high for beef meat. It can

also be noticed that fat percentage was clearly different between beef meat and meat by-products. Also, it is observed that the chemical composition of lung and spleen from this work is close to the chemical composition reported by Rogowski (1978).

The partial substitution of meat by-products for lean meat in sausages production was carried out to reduce its price.

Table 1. Chemical composition of fresh beef meat and meat by-products (lung and spleen), as % on wet weight basis.

Constituents	Beef meat	Lung	Spleen
Moisture	70.31	79.16	74.28
Protein	19.85	15.93	18.18
Fat	8.81	2.99	4.96
Ash	1.03	1.22	1.28
Carbohydrates	0.00	0.70	1.30

Data in Table 2 show the chemical composition and quality aspects of sausages samples (0,20,30 and 50% meat by-products). It is observed that the moisture content increase by increasing the meat by - products due to the higher moisture content in meat by-products than in beef meat. Protein content was slightly higher for control samples (0% meat by-products) than other samples. The replacement of beef meat by meat by-products in sausage samples decreased the content of fat due to the low content of fat for meat by-products and the reverse appeared with the ash and carbohydrates contents. The iron (Fe) content of sausages samples was increased by replacing part of beaf meat with meat by-products. Therefore, these sausage samples could be considered as iron-fortified. These findings are in agreement with Bittel *et al.* (1981b), who found that inceasing levels of mechanically separated spleen (MSS) resulted significantly in increasing iron concentrations in the frankfurters, whereas frankfuters made with 0, 5, 10 and 15% MSS contained iron content 16.5, 36.4, 64.8 and 80.4 ppm respectively. While, Bittel *et al.*, (1981a) found that iron countents of whole spleen, MSS and the residue of separation were 518, 762 and 246 ppm (on wet weight basis), respectively. They observed that the increased iron value of MSS is attributed to the concentrating effect of removing the low-iron connective tissue from the spleen mass. But zinc (Zn) contentof meat by-products containing sausages was slightly decreased as reported by Bittle *et al.* (1981b) who found that zinc concentration of frankfurters significantly decreased with increased level of MSS from 22.4 ppm with 0% MSS to 21.5 and 20.8 with 5.10 and 15% MSS, respectively. This effect may be attributed to the slightly lower level of zinc in spleen, Bittel *et al.* (1981a) found that the zinc contents of whole spleen and MSS were 20.9 and 19.7 ppm, respectively, compared to

beef muscle, which was 23 ppm (Hansard *et al.*, 1969). Emulsifying capacity (E.C.) was slightly lower for lung and spleen containing sausages than for control. Volkert and Klein (1979) found a strong positive linear coroiation between protein solubility and the emulsifying activity of proteins in general and in sausages in particular. Total volatile nitrogen (TVN) level, thiobarbituric acid (TBA) value and tenderness scores decreased, but water holding capacity (WHC) and plasticity increased with the replacement of beef meat with meat by-products. From these results it was observed that this replacement improved the quality aspects. Tarlagis *et al.* (1960) reported that malonaldehyde measurement is used to determine the rancidity and lipid oxidation, and Pavolvski and Palmin (1963) added that in case of uncooked tissue enzymes may take part in the decomposition of proteins. Decomposition of protein may produceds which in part are responsible for the meat putrid odors. On the other hand, they stated that accumulation of total volatile nitrogen (TVN) is related mostly to degradation of animal protein, which night be used for the detection of spoilage in animal products. It was observed from results that shear forces values of sausages samples decreased with the replacement of part of beef meat by meat by-products, This may be due to the low connective tissues of meat by-products as reported by Goldman *et al.* (1969) who found that the shear value for sausages produced from low and high connective tissue content meat was 0.5 and 0.79 kg/cm2, respectively. Bittel *et al.* (1981b) reported that control frankfurter (0% MSS) received a higher mean firmness score than those containing MSS However, MSS containing products were scored as firm.

Table 2. Chemical composition and quality aspects of sausages samples.

Parameters	0% Meet by-products	20% Meet by-products	30% Meet by-products	50% Meet by-products
Moisture	60.12	60.43	60.66	60.90
Protein	13.30	13.14	13.07	12.91
Fat	20.90	20.22	19.88	19.20
Ash	2.89	3.06	3.15	3.59
Carbohydrates	2.79	3.16	3.24	3.40
Fe ppm	18.50	68.04	85.26	95.81
Zn ppm	22.91	21.98	21.69	21.52
E.C. (ml oil/0.75g sample)	53.40	53.00	52.84	52.47
TVU (mg/100g sample)	6.29	5.80	5.56	5.07
TBA value (mg malonaldegyde/sample)	0.26	0.23	0.22	0.20
WHC (%)	56.32	58.93	60.24	62.85
Plasticity (Cm2)	3.95	4.60	5.53	6.08
Tenderness (kg/cm2)	4.10	4.00	3.90	3.70

Data in Table 3 show amino acid composition of sausages samples. No great difference was observed in the amount of amino acids between all sausages samples, although the replacement of beef meat with meat by-products caused slight decrease in the amount of amino acids.

Table 3. Amino acids composition of sausages samples (as gm/16 g nitrogen).

Parameters	0% Meet by-products	20% Meet by-products	30% Meet by-products	50% Meet by-products
Leucine	7.99	7.76	7.37	7.31
Isoleucine	4.73	4.69	4.66	4.63
Lysine	8.35	8.27	8.22	8.11
Methionine	2.34	1.49	1.25	1.17
Pherylalanine	4.29	4.11	4.00	3.98
Threonine	4.85	4.63	4.43	4.26
Tryptophan	1.21	1.20	1.19	1.18
Valine	5.75	5.68	5.64	5.52
Arginine	6.78	6.73	6.67	6.55
Histidine	2.95	2.86	2.82	2.73
Tyrosine	3.60	3.51	3.46	3.35
Cystine	1.49	1.40	1.39	1.38
Proline	5.49	5.44	5.40	5.37
alanine	4.20	4.12	4.08	4.01
Glutamic acid	15.45	15.07	14.96	14.73
Glysine	2.73	2.55	2.52	2.45
Aspartic acid	13.34	12.84	12.59	12.10
Serine	3.95	3.85	3.81	3.76

Data in Table 4 show cooking losses of sausages samples. It is observed that cooking loss decreased by increasing the percentage of added meat by-products. The changes in cooking loss were found to follow the changes of WHC of samples. This may be due to the relatively high collagen content of meat by-products which converted to gelatin during boiling and gelatin was able to bind water (Krilova and Liskovskaia, 1973).

Table 4. Cooking losses of sausages samples (%).

Parameters	0% Meet by-products	20% Meet by-products	30% Meet by-products	50% Meet by-products
Cooking loss (%)	16.2	15.3	14.6	13.7

Data in Table 5 show scores of sensory evaluation of sausages samples. It is ob-

served that meat by-products containing sausages were accepted like control and the acceptance increased with the increasing percentage of meat by-products. Bittel *et al.* (1981a) found that color scores increased with increasig the level of spleen in frankfurters and all frankfurters were rated acceptable for flavor, texture and color by the consumer panel. Increasing levels of spleen did not significantly alter the acceptability of frankfurters flavor and color. Consumer panel texture scores reflected the trend toward softer frankfurters with increased spleen noted by the quality attributes panel. Therefore, the replacement of beef meat with meat by-products in sausages improved the organoleptic properties like quality aspects and led to decreasing the cost of sausages.

Table 5. Cooking losses of sausages samples (%).

Parameters	0 % Meet by-products	20 % Meet by-products	30 % Meet by-products	50 % Meet by-products	Mean	Standard deviation
Color	8	8	9	9	8.5	0.5
Taste	9	9	9	9	9.0	0.0
Odor	8	8	8	8	8.0	0.0
Texture	8	8	9	9	8.5	0.5
Overall acceptability	8	8	9	9	8.0	0.5

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تأثير استبدال جزء من اللحم البقري ببعض منتجات اللحوم الثانوية علي إنتاج سجق رخيص

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لدراسة تأثير استبدال جزء من اللحم البقري ببعض منتجات اللحوم الثانوية علي إنتاج سجق رخيص ، تم إنتاج عينات سجق محضرة بإستبدال جزء من اللحم البقري بـ ٢٠ ، ٣٠ ، ٥٠٪ من منتجات اللحوم الثانوية (طحال ورئة بنسبة ١ : ١) وقد كان هناك نقص قليل في البروتين عن عينة الكنترول (٦٧٪ لحم بقري) (من ١٣,٣٠ إلي ١٣,١٤ و ١٣,٠٧ و ١٢,٩١٪ علي أساس الوزن الرطب علي الترتيب). ولم يوجد فرق معنوي بين كميات الاحماض الامينية بين العينات لكن وجد أن هناك انخفاض قليل في كمية الاحماض الامينية مع الاستبدال لكل عينات السجق. وقد زاد محتوي الحديد بينما انخفض محتوي الزنك بدرجة خفيفة في عينات السجق المحتوية علي منتجات لحوم ثانوية. وقد وجد أن استبدال جزء من اللحم البقري بمنتجات اللحوم الثانوية في خلطة السجق البقري حسنت القدرة علي الاحتفاظ بالماء والبلاستيكية والطراوة بينما انخفضت القدرة علي الاستحلاب لحد ما. وقد ظهر من التقييم الحسي أنه لاتوجد إختلافات ملحوظة في اللون والطعم والرائحة والقوام بين العينة الكنترول وعينات السجق المستبدل فيها منتجات اللحوم الثانوية. بناء علي ذلك فإن السجق المحضر باستبدال ٥٠٪ من اللحم البقري بكمية مساوية من منتجات اللحوم الثانوية يمكن أن يوصي بانتاجه تجارياً.