EVALUATION OF BUFFALO SPLEEN ABILITY TO ALTER COLOR AND IMPROVE FUNCTIONAL PROPERTIES OF CHICKEN SAUSAGE.

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ABSTRACT

Boiled buffalo spleen was incorporated in chicken sausage formulation in ratio 30 and 50 % as replaced chicken meat percent in blends B and C, respectively to alter color and improve functional properties of samples. Chemical, physical, cooking properties and sensory attributes of raw and cooked samples were analyzed. Also, Hunter color values and heme pigment of raw and cooked samples were examined.

The protein content of A control (0 % buffalo spleen) was slightly higher than blends B and C. The WHC and emulsifying capacity of blends B and C were higher than A (control). An increase in redness (a*), saturation index and a*/ b* ratio values were found in raw blends B and C. The nitroso - heme and total heme pigment values were increased with increasing level of spleen in raw samples. The decrease in diameter and cooking loss were less in blends B and C.

Hunter color values of samples were significantly different ($P < 0.05$) according to the cooking methods. No significant differences were found between odor, taste and overall acceptability in blends B and C for all cooking methods. It might be concluded that results of incorporated buffalo spleen 30 percent received high values in color and functional properties of chicken sausage and received a high level of acceptance.

Key words: chicken, spleen, color, heme pigments, cooking loss.

INTRODUCTION

Spleen is more rarely consumed in the United States than in certain other countries, but limited amounts of splenic tissue have been included in some potted meat, scrapple, and certain hot dogs

produced in some areas of the country. Many people of the world consider spleen a delicacy (Bittel et al.,1981). They added, external surface Hunter L values determined on freshly manufactured product indicated that increased levels of MSS (mechanically separated spleen) resulted in significantly darker frankfurters and increased concentration of nitroso-heme pigment and total pigment.

Fernandez et al., (1998) reported that added ingredients caused alteration in color. Therefore, Mendenhall (1989) and Trout (1989) suggested that myoglobin denaturation is related to pigment concentration of the raw products. Results by Hunt et al., (1994) indicated that the oxidative state of myoglobin at cooking plays a major role in cooked color. When the raw product contains more metmyoglobin (met Mb), the cooked products will appear more done than when the product contains more oxymyoglobin (oxy Mb). Moreover, Slesinski et al (2000) reported that poultry producers can reduce pink color development in further - processed products by selective addition of dairy proteins.

Several studies have been carried out by Hanaa and Ibrahim (2000), Zoba (1991) and Darwish (1993), they found that incorporation of lung and spleen; lung and low nucleic acid dried yeast improved functional properties and nutritional values of sausage samples, respectively.

Ibrahim (1997) found that, the spleen had higher WHC (water holding capacity) than other varieties of meat studied. In addition, the high WHC value of spleen was expected because its proteins structure having a high blood ratio which is responsible for binding water and fat in meat emulsion (Wilson et al., 1981).

The objective of this research was to:

1- Evaluate the ability of buffalo spleen to alter the color of chicken sausage and improve functional properties.

2- Obtain information about the effect of cooking methods on Hunter color values, heme pigments and cooking properties of samples.

MATERIALS AND METHODS

Materials

Eight female chicken (more than one year old, with an average weight of 3.5 kg) were obtained from the Ministry of Agric., Cairo, Egypt. Samples were slaughtered, defeathered, eviscerated and the edible carcasses were cleaned and put into ice box and transported to the Laboratory of Meat and Fish Tech. Res. Dept., Food Tech. Res. Inst., Agric. Res. Center, Giza, Egypt. The samples were cleaned, removed the skin and fat, deboned and the muscles (breast breast and legs) were cut into small pieces, packaged and stored at – 18 °C until were made sausage blends.

Five buffalo spleen were obtained from slaughter - house, Helwan, Cairo, Egypt. The samples were veterinary examined and were found free from infection diseases and then transported to the laboratory inside in ice box. The samples were cleaned and precooked in boiling water solution containing 2 % salt for 20 min, cooled, then cut in small pieces, packaged and stored at – 18 °C until were made sausage blends.

Fat tissue (sheep tail) was cleaned and cut in small pieces, packaged and stored at – 18 °C.

Fine rusk, spices and salt were bought from local market in Giza City.

Spices mixture was prepared according to Hanaa and Ibrahim (2000).

Technological methods

Preparation of sausage formula

Three blends of sausage were prepared as in Table1 (Hanaa and Ibrahim, 2000). The ingredients were mixed (emulsified) using laboratory emulsifier for sausage (Hobart, Model 84486, USA) and mixing was carried out for 8-10 min. Sodium nitrite (0.015 %) was dissolved in small amount of water before being added to the formula.

The obtained emulsion was stuffed in previously cleaned and prepared natural mutton casings, then packaged in polyethylene and stored at – 18 °C until analysis (at 0,2,4 and 6 months).

Table 1: Formulation of different sausage blends

Ingredients %	(A) control	(B) blend	(C) blend
Chicken meat	67.0	46.90	33.50
Buffalo spleen	—	20.10	33.50
Minced fat tissues	15.00	15.00	15.00
Ice water (flaskers)	10.00	10.00	10.00
Fine dry rusk	5.00	5.00	5.00
Sodium chloride	2.00	2.00	2.00
Spices	1.00	1.00	1.00

Cooking methods

Frozen sausage were thawed overnight at 5 °C refrigerator and cooked according to Cannell et al., (1989). Sausage was cooked to well – done and blotted with paper towels prior to weighing.

Boiling: Samples were boiled in water for 13 min (sausage: water, 1:2 w/v). The internal temperature reached 90 °C.

Roasting: Samples were placed on a cookie sheet and roasted in an electric oven at 180 °C for 15 min. The internal temperature reached 88 °C. A thermocouple (Omega, Model 199, USA) was used to measure the internal temperature of cooked samples.

Cooking loss, yield and diameter measurements.

Samples were weighed before and after cooking after equilibrium to room temperature (20 °C) to determine cooking loss. Cooking loss % = (weight of raw samples – weight of cooked samples) /weight of raw sample X100. The yield % was calculated. The diameter of samples was measured before and after cooking and the data were expressed as percent changes in sausage diameter.

Fat and moisture retention

Fat and moisture retention after cooking was calculated using the equation given by Cannel et al. (1989).

$$\%\text{Retention} = \frac{\text{Cooked wt. Percentage xfat or moisture (from cooked)}}{\text{Raw wt. X percentage fat or moisture (from raw)}} \text{ x100}$$

Physical analysis

Hunter colour values

Hunter colour values (L*, a* and b*) of raw and cooked sausages were measured using colourimeter (colour Tee PCM color Meter, colour Tec, NJ,USA). Thawed raw sausages were wrapped in clear polyethylene, and reading were taken. Cooked sausage samples were cooled at 20-25 °C. Small square slices were cut. These squares were sliced parallel to the flat surface in the center of sausage. The brown crust on the outside of the sausage was removed. Samples were wrapped in plastic food wrap, and the colour was measured.

The value L* was the lightness ranged from 0 to 100; a* was chromatically where positive value indicating redness and negative value indicating greenness; while positive value of b* indicating yellowness and negative value indicating blueness. Four random spots on each sample were measured and the average data were taken.

Saturation index: $S = (a^2 + b^2)^{1/2}$, higher values indicate more vivid redness; hue angle $(b/a)^{-\tan}$ higher values indicate less redness and a* / b* ratio higher values indicate more redness were calculated according to Ana and Joseph (1996).

Expressible water (E.W.) and water holding capacity (WHC)

The E.W. of sausage was determined using the centrifugation method given by Alvarez, et al. (1992). The WHC of sausage was calculated (WHC %) = (moisture %) – (E.W.%).

Emulsifying capacity (E.C.): was determined according to the method described by Webb et al. (1970).

Analytical methods

Proximate composition and pH value

Moisture, protein, fat and ash contents of samples were determined according to AOAC (1995). Carbohydrate content was calculated by difference. **The pH value** : was measured using a pH–meter (A512, USA).

Titratable acidity: was determined and expressed as ml / NaoH 0.1 N /100g sample according to Keeton and Melton (1978).

Total volatile nitrogen (TVN): was etermined according to the method described in AOAC (1980).

Amino nitrogen (Amino N): was estimated using the formal volumetric titration method as described by Kolochov (1952).

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

Pigment determination

Total and nitroso - heme pigments were determined by the method of Bittell et al. (1981 b).

Sensory evaluation

Cooked sausage blends were cut into pieces, warmed in oven and presented to 10 staff members in the Meat and Fish Tech. Res. Dept., Food Tech. Res. Inst., Agric. Res. Center. A 5. Point hedonic scale (1being dislike very much to 5 being like very much) was used to evaluate sensory attributes, color, odor, taste, texture and overall acceptability of sausage blends Gelman and Benjamin (1989).

Statistical analysis

The analysis of data was carried out by ANOVA. While, Dumcan's multiple range test was used to test the differences among means (SAS, 1992).

RESULTS AND DISCUSSION

1- Proximate composition, quality aspects and physical properties of raw sausage blend.

Data in Table 2 show that the moisture contents ranged from 61.35 % in A (control) to 61.84 % in blend C. The ash and carbohydrate contents were higher in blends B and C than A (control). Protein content was slightly higher for control sample than others. The incorporated spleen in blends B and C decreased the fat content . Mutkoski and Schurer (1981) reported that these fresh edible meat by-products such as brain, liver, lung and spleen are rich in protein, vitamins and minerals, most are cheaper than other meat cuts. In addition, Kiernat et al. (1964) studied the chemical composition of spleen tissue of raw edible offals of beef and found 78.6% moisture, 17.7 % protein, 3.1% fat and 1.4 % ash.

Also, data in Table 2 show some quality aspects of samples, it was observed that the pH value of blends B and C (5.60 and 5.65) was less than A control (5.75). The differences which found in pH and acidity values might be due to the variation in the blends constituents. The amino nitrogen ranged from 22.85 to 27.34 mg/100g and run in the permissible limits reported by Constantine and Cornelio (1968) [70 mg /100g]. The TVN of A (control) was

Table 2: Proximate composition, quality aspects and physical properties of raw sausage blends.(On dry weight basis)

Determination	A (control)	B	C
Moisture (%)	61.35	61.65	61.84
Protein (%)	35.42	34.94	34.46
Ash (%)	6.24	8.87	10.43
Fat (%)	51.49	48.63	46.78
Carbohydrate (%)	6.86	7.56	8.33
pH value	5.75	5.60	5.65
Titratable acidity (mg Nach/2g sample)	0.91	1.10	1.02
Amino nitrogen (mg/100g)	22.85	26.13	27.34
Total volatile nitrogen (mg/100g)	14.88	13.95	13.52
TBA value (mg Malonaldhyde/kg sample)	0.72	0.81	0.94
Water holding capacity (WHC %)	36.24	37.21	37.62
Expressible water (EW %)	25.11	24.44	24.22
Emulsifying Capacity (EC ml oil/0.75g sample)	46.55	47.82	47.75

Results are average of three replicates.

slightly higher than other samples, but fall in the permissible limits (EOS, 1985). Moreover, the TBA value of A (control) was less than blends B and C; this might be due to the incorporated spleen in blends B and C, which was pre-cooked before added in formula.

On the other hand, results in Table 2 reveal some physical properties of samples. It was observed that incorporated spleen in blends B and C improved the WHC and emulsifying capacity and decreased expressible water. Volkert and Klein (1979) found a strong positive linear concentration between protein solubility and the emulsifying activity of proteins in general and in sausages in particular. These results are in agreement with those reported by

Wilson et al., (1981), Ibrahim (1997), Abbas and Ibrahim (1998) and Hanaa and Ibrahim (2000).

2- Effect of incorporation of buffalo spleen in raw sausage blends on:

One- Hunter color values

Data in table 3 demonstrate the differences in Hunter color between samples. It can be seen that lightness (L*) values were significantly different between samples, the highest value was found in A (control) and the lowest value was found in blend C. An increase in redness (a*), saturation index and a*/b* ratio values were found in blends B and C due to incorporate the spleen in blends when compared to A (control) which had the lowest value. Also, the yellowness (b*) value of blend B was higher than blends A and C.

Table 3: Hunter color values (L*, a*, b*) of raw sausage blends.

Sausage blends	L*	a*	b*	Saturation index	Hue angle	a*/b* ratio
A (control)	52.47 a ± 0.69	5.07 b ± 0.59	9.74 b ± 1.34	10.98 b ± 2.08	62.50 ± 10.22	0.52 c ± 0.29
B	43.25 b ± 1.96	11.10a ± 0.92	11.41a ± 0.92	15.92 a ± 1.73	45.79b ± 4.87	0.97ab ± 0.18
C	35.30 c ± 2.13	9.36 b ± 0.71	9.36 a ± 1.10	14.66 a ± 0.98	39.69c ± 5.26	1.21 a ± 0.18

abc Means in a column with different letters are different ($P \leq 0.05$).
Results are average of three replicates.

Regarding, the hue angle values significant differences were observed among treatments, the highest value was found in blend A and the lowest value was found in blend C. These results revealed that incorporated spleen in sausage blends decreased the values of hue angle which indicate more redness in samples. Sharaf (1993) found that all meat cuts (beef and camel) had higher absorbance value at 542 nm than chicken meat. This could be due to its high myoglobin content. Moreover, Bittle et al., (1981 b) found that the increased intensity of brown-red pigmentation of frankfurters with increased level of MSS (mechanically separated spleen) was most probably a result of abundant quantity of hemoglobin in the MSS. In addition, Cofrades et al., (2000) reported that an increase in the

proportion of plasma protein produced a significant ($P < 0.05$) increase of L * and b* values. These results are closed to those reported by Ibrahim (2001) and Slesinski et al (2000).

b-interaction effects for heme pigment

The interaction effects for total and nitroso - heme pigment determination are presented in Table 4.

Table 4: Interaction effects for heme pigment of raw sausage blends. (ppm/hematin)

Sausage blends	Nitroso heme pigment	Total heme pigment
A (control)	8.70	183.60
B	16.82	231.20
C	21.17	427.72

Results are average of three replicates.

The initial total pigment concentration increased linearly with increased level of buffalo spleen (30-50 %) in sausage blends, which ranged from 183.60 in (A control) to 427.72 ppm /hematin in (blend C). As the same trend, the nitroso-heme pigment values was increased with increasing level of spleen in samples, values ranged from 8.70 in (A control) to 21.17 ppm / hematin in (blend C). These results indicated that incorporated spleen in sausage blends increased the values of heme pigment than control sample which had the lowest values. These results are in agreement with those found by Bittel et al., (1981b) and Fernandez et al., (1998).

3- Effect of cooking methods on yield, diameter change and cooking properties of sausage blends.

Data presented in Table 5 reveal that yield values were increased in blends B and C than blend A (control) in all cooking methods, but the yield values of boiled were higher than roasted samples.

The degree of shrinkage is important in maintaining quality standards of beef patties prepared in food service establishments. Therefore, changes in diameter and thickness must be considered when benefits of meat additives are evaluated (Ana and Joseph, 1996). The results in Table 5 demonstrated that the decrease in diameter were less in blends B and C than A (control) after cooking. Field and Riely (1974) reported that incorporation MSS

into finely comminuted products improved emulsion stability, texture score, and reduced shrink in bologna due to lower connective tissue content of machine deboned mutton.

Table 5: Effect of cooking methods on yield, diameter change and cooking properties of sausage blends (%).

Sausage blends	Cooking methods	Yield	Decréasei n diameter	Cooking loss	Fat retention	Moisture retention
A (control)	Boiling	68.39	10.50	31.61	49.15	65.38
B		83.77	4.76	16.23	54.13	81.54
C		88.07	4.56	11.93	60.93	85.59
A (control)	Roasting	60.41	22.03	39.59	46.45	56.57
B		78.75	19.53	21.25	57.22	74.61
C		82.46	14.29	17.54	63.29	78.54

Results are average of three replicates.

The effect of cooking methods on cooking properties (cooking loss, fat and moisture retention) are presented in table 5. These results show that, cooking losses percentage of blend B and C were less than A (control). Gillett et al., (1976) reported that salami made from desinewed meat exhibited less shrinkage, improved panel ratings, and the absence of jelly pockets in contrast to salami made from nondesinewed meat. Also, the results reveal that the higher percentage of fat and moisture retention were found in blends B and C than blend A (control) for all cooking methods. Most of losses at low fat level have been attributed to moisture losses, while that at higher fat levels being mainly fats losses (Cannell et al., 1989).

In general, These results in Table 5 revealed that the incorporated buffalo spleen improved the percentage of yield, fat and moisture retention. Moreover, it decreased the cooking loss (%) and reduced shrink in sausage.

4- Effect of cooking methods on Hunter color values (L* , a* , b*) of sausage blends.

Data in Table 6 reveal the differences in Hunter color between samples. Lightness (L*) values of samples were significantly

different ($P< 0.05$) according to the cooking methods. Lightness value in roasted sausage was less in blends B and C than boiled sausage, but A (control) was not significantly affected with both boiled and roasting methods.

Significantly higher values in redness (a*), saturation index and a*/b* ratio were found in blends B and C than A (control), but the values of boiling method were less than the roasting method. The yellowness (b*) values were not significantly different in A (control) and B for both boiling and roasting methods, but significant variation were found in C blend and it had the lowest values.

Table 6: Effect of cooking methods on Hunter color values (L*,a*, b*) of sausage blends.

Determination	Boiling			Roasting		
	A (control)	B	C	A (control)	B	C
L*	57.02a ± 4.01	37.71b ± 2.74	35.46 b ± 1.65	49.11a ± 0.96	26.82 c ± 2.28	24.55c ± 1.69
a*	7.54 c ±1.42	12.35b ± 2.19	14.60 b ± 2.49	8.75 c ± 0.95	21.07 a ± 2.60	16.54ab ± 2.22
b*	11.06a ± 0.97	10.83ab ± 0.85	9.89 b ± 1.25	15.55a ± 0.32	10.96ab ± 0.89	9.52 b ± 1.03
Saturation Index	13.39b ± 1.68	16.43ab ± 1.38	17.63ab 1.77	17.84ab ± 1.57	23.75 a ± 0.69	19.08a ± 1.89
Hue angle	55.72a ±3.44	41.25 b ± 4.61	34.11 b ± 6.15	60.63a ± 2.56	27.48 c ± 7.39	29.92c ± 7.18
a*/b* ratio	0.68 b ± 0.08	1.14 ab ± 0.61	1.48 a ± 0.35	0.56 b ± 0.30	1.92 a ± 0.92	1.74 a ± 0.75

Results are average of three replicates.

abc Means in a raw with different letters are significantly different ($P< 0.05$).

Also, the data presented in Table 6, illustrated that the hue angle values was significantly varied between treatments according to the cooking methods. The values of blends B and C in roasted samples were less than blends B and C in boiled samples, but the highest values of hue angle was found in A (control) in both boiled and roasted samples. These results revealed that the incorporated buffalo spleen in blends B and C increased the redness, saturation

index and a*/b* ratio values and decreased the lightness and hue angle values when compared with A (control). These results are in agreement with those reported by Fernandez et al., (1998) and Ibrahim (2001) who found that addition of some ingredients in rabbit burger effected Hunter color by improving the redness, yellowness, saturation index and a*/b* ratio than control sample.

5- Effect of cooking methods on interaction effect for heme pigment.

Data presented in Table 7 reveal the effect of cooking methods on heme pigments of sausage samples. It was observed that values of nitroso heme pigment were increased in boiled and roasted samples, but the level of increased values was higher in roasting than boiling cooking. Therefore, Mendenhall (1989) and Tourt (1989) suggested that myoglobin denaturation is related to pigment concentration of the raw product.

Table 7: Effect of cooking methods on interaction effect for heme pigment. (ppm/ hematin).

Sausage blends	Nitroso heme pigment		Total heme pigment	
	boiling	roasting	boiling	roasting
A (control)	22.16	35.25	125.45	198.75
B	44.95	71.34	162.52	267.24
C	54.25	93.76	295.66	475.68

Results are average of three replicates.

Also, it was observed from data in Table 7 that the cooking methods affected the values of total heme pigment of samples. Values of total heme pigment were increased after roasting samples, but the values of it were decreased after boiling samples, this might be due to the concentration of pigment after roasting which resulted from evaporation of moisture by heating, while some pigments were dissolved in water during boiling process, respectively. These results are in agreement with those found by Hunt et al., (1994).

6-Sensory evaluation of cooked sausage blends

Data presented in Table 8 show the effect of cooking methods on sensory evaluation of sausage blends.

The color values of sausage were significantly different ($P < 0.05$) between treatments, the data revealed that blend B had higher scores than blend C, and the lowest values of color were found in blend A (control) for all cooking methods.

Table 8: Sensory evaluation of cooked sausage blends.

Sausage blends	Cookingm ethods	Color	Odor	Taste	Texture	Overall acceptabi-lity
A (control)	Boiling	1.72 d	3.52 b	3.46 b	4.25 b	2.32 c
B		4.55 a	4.20 a	4.36 a	4.49 a	4.58 a
C		1.88 b	4.22 a	4.20 a	4.15 b	4.40 a
A (control)	Roasting	1.88 d	3.75 b	3.75 b	4.37 b	2.50 c
B		5.00 a	4.36 a	4.45 a	5.00 a	5.00 a
C		4.38 ab	4.35 a	4.36 a	4.50 ab	4.42 ab

Abc Means in â column with different letters are significantly different ($P \leq 0.05$).

No significant differences were found between odor and taste in blends B and C, but significant differences were found between samples and blend A (control) for all cooking methods. However, the texture scores were varied between samples, where the highest values of texture were found in blend B for all cooking methods.

The overall acceptability scores, revealed that the highest values of score were found in blend B, and the lowest values of score were found in blend A.

These results demonstrated that increasing levels of buffalo spleen in sausage blends inversely affected the increase in color, but not effected other qualities panel evaluation of samples. Overall, these results indicated that as much as 30 % spleen could be incorporated in sausages without seriously altering or decreasing consumer acceptability. In general, methods of cooking appeared to have little impact on sensory analysis between samples.

These results are closed to those reported by Bittel et al. (1981b) their results illustrate that increasing the level of MSS in products intensified color score and decreased firmness score, but addition of 15% MSS had a detrimental effect on the characteristics of frankfurters particularly binding, texture and overall

acceptability, and after heat processing, no fat caps were observed on any of the products, lacked the "snap" and "bite" of the more acceptable frankfurters. Blaker et al., (1959) reported that beef roast cooked in foil may have steamed flavour.

These results are in agreement with those reported by Field and Riley (1974) and Gillett et al., (1976).

CONCLUSION

It could be concluded that incorporation of buffalo spleen as 30 % percent in chicken sausage :

a- Improved the percentage of yield, fat and moisture retention, decreased the cooking loss (%) and reduced shrinkage in sausage.

b- Increased redness (a*), saturation index and a*/ b* values in chicken sausage. c- Increased nitroso - heme and total heme pigments values in chicken sausage samples. d- Samples remained darker on each surface and contained more pigment than control sample after cooking methods, and received a high level of acceptance.

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الملخص العربي

تقييم مقدرة الطحال الجاموسى على تغيير اللون و تحسين الصفات الوظيفية فى سجق الدجاج.

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تم إدخال الطحال الجاموسى المسلوق فى تركيبة سجق الدجاج بنسبة ٣٠، ٥٠ % كنسبة استبدال من لحم الدجاج فى الخلطة B ، C بالترتيب لتغيير اللون وتحسين الصفات الوظيفية بالعينات. تم التحليل الكيميائى والفيزيائى وصفات الطبخ والصفات الحسية للعينات الخام والمطهية. أيضاً تم فحص قيم ال Hunter color وصبغات الهيم للعينات الخام والمطهية.

زاد محتوى البروتين بنسبة طفيفة فى الخلطة A الكنترول (لا تحتوى على الطحال الجاموسى) عن الخلطات B ، C. ازدادت القدرة على مسك الماء والقدرة الاستحلابية فى خلطات B، C عن الخلطة A الكنترول. حدثت زيادة فى قيم الاحمرار (a*) وال Saturation index وال a*/b* ratio فى الخلطات الخام B ، C. تزداد قيم صبغة النيتروزهيم وصبغة الهيم الكلية بزيادة نسبة الطحال فى العينات . انخفض النقص فى القطر وفقد الطبخ فى الخلطات B، C.

وحدثت فروق معنوية ($P< 0.05$) فى قيم ال Hunter color طبقاً لطريقة الطهى. لا توجد اختلافات معنوية فى الرائحة والتذوق أى القبول العام للخلطات B ، C فى كل طرق الطهى . وتلخص النتائج ادماج نسبة ٣٠ % من الطحال أعطت أعلى القيم فى اللون والخواص الوظيفية لسجق الدجاج ونالت قيم عالية فى القابلية العامة.