J. Agric. Sci. Mansoura Univ., 30 (12): 7749 - 7763, 2005

CHEMICAL PROPERTIES, MICROBIOLOGICAL QUALITY AND SENSORY EVALUATION OF CHICKEN AND DUCK LIVER PASTE (FOIE GRAS)

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ABSTRACT

Liver paste (Foie gras) is a French term, meaning "fatty liver" was produced traditionally from geese and ducks. Chickens are also used in the making of Foie gras. The present study is dealing with properties and quality of raw chicken and duck liver in comparison with manufactured liver paste (Foie gras). Raw chicken liver contained 24.60 % protein, 6.00 % fat, 1.40 % ash and 66.80 % moisture. The average mineral values were 83.65, 50.75, 5.29, 1.15, 0.154, 0.683, 0.317 and 0.066 µg/g , Fe, Zn, Cu, Mn, Cd, Pb, Ni, and Cr, respectively. Processing of liver paste (Foie gras) changed the composition of raw liver; due to loss of moisture, fat releasing, and butter addition as fat source. Chicken liver paste contained 27.8 % moisture, 10.1 % protein, 58.2 % fat and 0.8 % ash. Mineral contents were 68.90, 40.50, 1 60, 1.1, 0.08, 0.22, 0.04 and, 0.04 µg/g, Fe, Zn, Cu, Mn, Cd, Pb, Ni, and Cr, respectively Chemical, microbiological, and sensory evaluation of liver paste (Foie gras) manufactured from raw liver and preserved by addition of 1000 ppm of both benzoic acid (BA) or sorbic acid (SA) and mixture of 500 ppm of both BA plus SA with or without pasteurization at 85°C were studied during the storage period for 9 days at 4°C. Presumably, mixing of liver paste (Foie gras) from chicken liver with 500 ppm of both BA plus SA and pasteurized the product at 85°C could be recommended for lowering TBA, TVN, PV, FFA, ammonia, saponification value and hence for inhibiting lipid oxidation and preventing rancidity to an extent up to nine days of refrigerated storage (4°C). This level is also recommended as a preservative agent to inhibit bacterial deterioration of chicken liver paste (Foie gras). Sensory evaluation showed that, liver paste from chicken were very much acceptable from the standpoint of taste, odor, appearance, color and texture. In comparison to liver paste of duck, the results proved that no significant differences observed between liver paste from chicken and duck liver paste.

Keyword: Raw chicken liver- Chicken liver paste (Foie gras)- Duck liver paste Preservation-Chemical evaluation- Microbiological evaluation- Sensory evaluation.

INTRODUCTION

Liver paste (Foie gras) is a French term, meaning "fatty liver". It is a delicate rosy color with mottling of beige. The flavor is extraordinarily rich and the texture silky smooth (*Epicurious Food Dictionary, 1995*). Four grades of traditional gastronomic "Foie gras" are commercially available (*El - Moueffak et al., 1995*). Fresh (cold storage for a few days, mainly for restaurants), half cooked (shelf- life at 4°C, less than 42 days), pasteurized (shelf-life up to 6 months at + 4°C), and sterilized (room temperature storage, up to several years). Each grade corresponds to a particular standard of quality of this food, with typical organolyptic characteristics and specific process.

The fat liver, internationally called "Foie gras", was produced traditionally from geese. However, in recent years there has been a widespread change to the use of ducks rather than geese, mainly for financial

reasons (*SCAH, 2005*). Chickens are also used in the making of (Foie gras) (*Epicurean Com, 2005*). Thus the aim of this study was carried out to investigate chemical, microbiological, and sensory evaluation of chicken and duck liver paste as fresh pasteurized products.

MATERIALS AND METHODS

Materials:

Chicken and duck livers were purchased from local market. Livers of optimum and homogeneous quality were selected, cut off the main lobe and wrapped in polyethylene bags. The sample lobe are mixed and divided in bags. Liver to be used in processing were frozen at - 18°C for one week.

Preparation of liver paste (Foie gras) from chicken and duck livers:

Chicken and duck liver paste (Foie gras) produced according to the method of *Guy et al.*, (*1991*) as follows:

The liver samples (10 kg) thawed at 2°C and soaked in water and allowed to reach room temperature for easier handling so that veins and connective tissue can be removed. Liver samples were cooked in wire baskets and cook in water approximately 30 min. The yield of the processed liver was 6.5 kg

from the raw weight (10kg). Onion cut in small pieces and cardamon in cheesecloth added to liver during cooking. Cooked liver and 3.5 kg butter (with chicken liver), 2 % salt are minced approximately 5 min. until the ingredients are uniformly distributed. To reduce liver pieces a rapid meat chopper operates at speeds up to 3000 rpm are used. Dry ice added to keep liver temperature down to mechanical mixture and mix approximately 1-2 min. to assure proper distribution of salt and flavoring and also to increase the binding capacity of the soluble protein in the mixture. The liver paste (Foie gras) packed in jars and used for the different treatments.

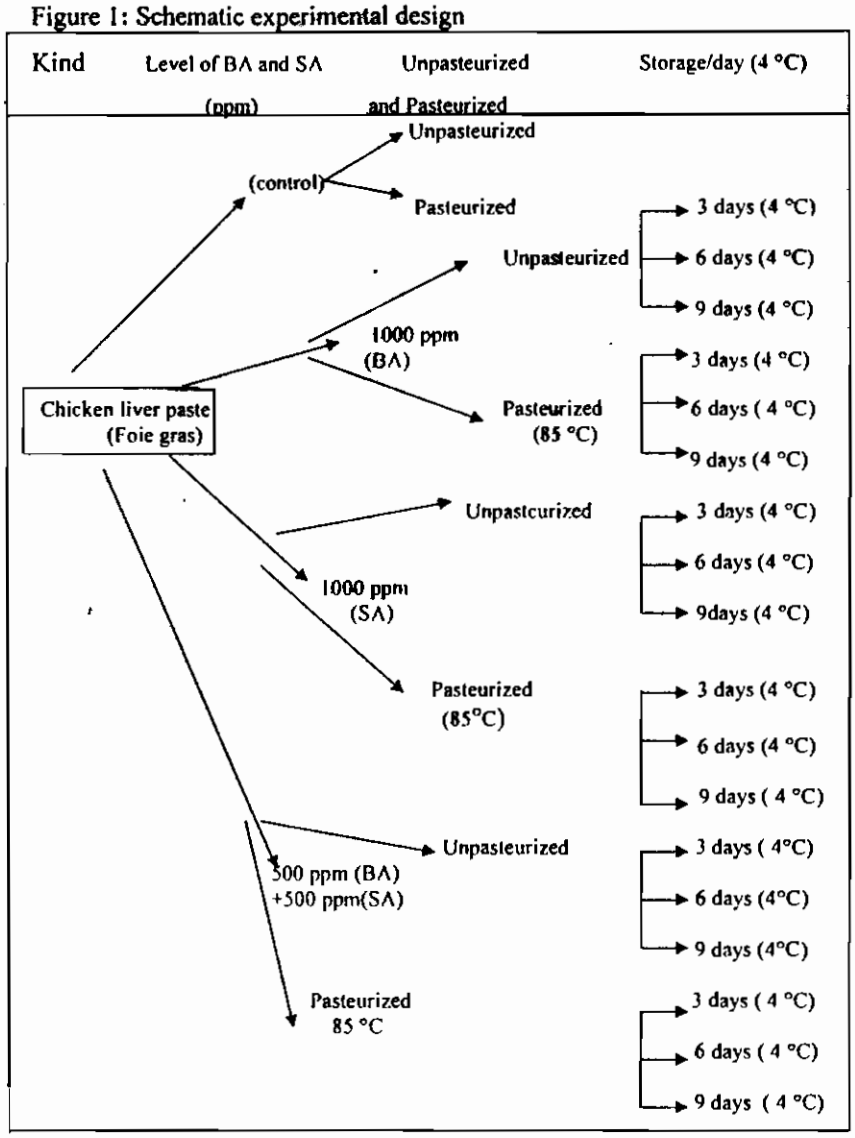
Experimental design:

Chicken liver paste (Foie gras) manufactured from raw liver preserved by addition of 1000 ppm of both benzoic acid (BA) or sorbic acid (SA) and mixture of 500 ppm of both BA plus SA with or without pasteurization at 85°C and storage for 3, 6, and 9 days at 4°C.

Analytical methods:

Samples were analyzed before and after treatments and during storage periods chemically and microbiologically. Sensory evaluation were also evaluated.

Figure 1: Schematic experimental design



BA: Benzoic acid (as antimicrobial). SA: Sorbic acid (as antimolds and yeasts).

BA + SA: Benzoic acid + Sorbic acid (as synergists)

Chemical analysis:

Moisture, protein, fat, ash, total volatile nitrogen (TVN), ammonia, peroxide value (PV), free fatty acid (FFA) and saponification value (SV) were determined according to the methods described in the *AOAC (1995)*. Thiobarbituric acid (TBA) value was colorimetrically measured at 538 nm as Mentioned by *Pearson (1976)*. The results were expressed as mg malonaldehyde/kg sample. Minerals were measured by Atomic Absorption Spectrophotometry (Perkin-Elmer 2380). Iron (Fe) was measured at 248.3 nm, copper (Cu) at 324.8 nm, zinc (Zn) at 319.9 nm, cadmium (Cd) at 228.8, lead (pb) at 217.0 nm, nickel (Ni) at 232.0 and chromium (Cr) at 240.7 nm with hollow cathode lamps according to *AOAC (1995)*.

Microbiological study:

Samples of liver paste (Foie gras) pasteurized and unpasteurized were bacteriologically investigated. Twenty-five gram samples of each of tested samples were suspended under aspectic conditions in 225 ml of peptone water (0.1%). A serial decimal dilution was made using the same medium and plated onto growth media in duplicate. Microbial groups (*Aerobic bacteria, Staphylococci, Salmonella spp.*, coliform bacteria, molds and yeast's) were determined according to American Public Health Association for foodstuff examination *(APHA, 1992)*.

Sensory evaluation:

Sensory characteristics of samples (Foie gras from chicken and duck livers) were investigated by 10 panelists to evaluate, taste, odor, appearance, color, texture and overall acceptability on a 10-point scale where (10) is the best and (1) is the lowest.

Statistical analysis:

Data were subjected to statistical analysis using computerized analysis of variance and Duncan's multiple range taste procedures, *(SAS, 1998)*.

RESULTS AND DISCUSSION

Composition of raw chicken liver, chicken liver paste and duck liver paste:

Composition of raw chicken liver and chicken liver paste (Foie gras) product manufactured from its were studied (Table 1). The raw liver samples were rich in protein, which contain mean value 24.60%. The fat content, ash and moisture were 6.00, 1.40 % and 66.80 % respectively. Dry matter, protein and lipid content of liver in chicken were 31.4, 64.0 and 28.0 % DM, respectively (*Mavromichalis et al., 2000*). Minerals (Zn, Cu, Fe, Mn, Cd, Pb, Ni and Cr) were also determined which accumulate in the liver (*Sola et al., 1997*). The results obtained show that raw chicken liver contained higher concentrations of Fe (83.65 µg/g) and Zn (50.75 µg/g). Regarding to Cu, the level was (5.29 µg/g), followed by Mn (1.15 µg/g). *Hecht (1996)* reported that if Cu-enriched feeds are used, Cu concentration increases in liver. On the other hand, the other metals, Cd, Pb, Ni and Cr were detected in lower levels which recorded 0.154, 0.683, 0.317, and 0.066 µg/g, respectively. The

concentrations (µg/g DM) of zinc, iron, copper and manganese in chicken liver were 84.4, 592.8, 16.2 and 12.8, respectively (*Mavromichalis et al., 2000*). The different concentrations of metals probably results from the different diets (*Abou-Arab, 2001*). *Blum (1997)* reported that the liver has a composition, which does not depend on the length of force-feeding period, but only on its weight. Mean values found in the literature are 2.9, 190.2, 11.0, and 93.3 µg/g for Mn, Fe, Cu, and Zn, respectively (*Jorhem et al., 1984*). In Egypt, *Abou-Arab (2001)* reported that the levels of Fe, Zn, Cu, Mn, Cd and Pb ranged from (82.6 to 116.4), (19.8 to 26.2), (38.4 to 86.4), (1.9 to 4.8), (0.082 to 0.112), and (0.08 to 0.11 µg/g wt. weight) in liver samples from bovine, buffalo, elk, sheep and goat, respectively. In the literature consulted no more available data relating to the study of trace elements in chicken liver or chicken liver paste (Foie gras).

Processing of chicken liver paste (Foie gras) from the raw chicken liver produced different composition of the product due to loss of moisture, fat releasing and butter addition as fat source. Chicken liver paste contained 27.8 % moisture, 10.1 % protein, 58.2 % fat and 0.8 % ash. Mineral contents were 68.90, 40.50, 1.60, 1.1, 0.08, 0.22, 0.04 and 0.04µg/g Fe, Zn, Cu, Mn, Cd, Pb, Ni and Cr, respectively. Fat release during cooking depends on temperature and length of the heating process (*Blum, 1997*). It increases with the liver weight and is related to its composition. Liver paste (Foie gras) from geese lost less fat during cooking and there was only a small influence of the liver weight, those of mule ducks lost more, the loss increasing quickly with the liver weight; those of muscovy ducks lost a maximum value (56%) independently of the liver weight (*Blum, 1997*). On the other hand, *Salichon et al, (1994)* reported that the lipids contents were significantly ($P< 0.001$) higher in duck Foie gras (62.6% in muscovy and 60.5% in mule ducks sv 54.6% in gees), while water, protein and ash contents were lower, which recorded (27.4-37.7), (6.4-8.3), and (0.5-0.7%) with gees, mule ducks and muscovy, respectively. To sensory evaluation the Foie gras from chicken liver, the same constitute of Foie gras from duck liver was applied (Table 1).

Table (1):Proximate and minerals composition of raw chicken liver and liver paste (Foie gras) from its and comparing by Foie gras from duck liver.

Components	Raw chicken liver	Foie gras from Chicken liver	Foie gras from Duck liver
Proximate% (wet weight)			
Moisture	66.80	27.80	28.60
Protein	24.60	10.10	9.40
Fat	6.00	58.20	56.80
Ash	1.40	0.80	0.90
Minerals (µg/g wet weight)			
Fe.	83.65	68.90	79.60
Zn	50.75	40.50	51.10
Cu	5 29	1.60	3 30
Mn	1.15	1.10	3.40
Cd	0.154	0.08	0.26
Pb	0.683	0.22	0.80
Ni	0.317	0.04	0.12
Cr	0.066	0.04	0.08

Chemical, microbiological and sensory evaluation of chicken liver paste (Foie gras):

Lipid oxidation, microbial spoilage and associated changes are a major cause of quality deterioration of meat during storage. Problems associated with lipid oxidation are of importance as they relate to flavor deterioration and loss of nutritional values, thereby affecting the acceptability of meat during storage (*Gray and Monahan, 1992*). Chemical, icrobiological, and sensory evaluation of chicken liver paste (Foie gras) manufactured from chicken liver and preservative by 1000 ppm of both benzoic acid or sorbic acid and mixture of 500 ppm of both benzoic acid plus sorbic acid as well as pasteurized at 85 °C or unpasteurized were studied during the storage periods for 0, 3, 6, and 9 days at 4 °C (Tables, 2-8).

Rancidity :

Table 2 clearly shows that, storage periods had significantly (P< 0.05) increased thiobarbituric acid (TBA) in pasteurized or unpasteurized samples with or without BA and SA. However, samples pasteurized at 85 °C were significantly (P< 0.05) decreased TBA compared to unpasteurized control treatment at 9 storage days only.

Table(2): Change in TBA values (mg malonaldehyde/kg) of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85°C or unpasteurized during storage period.

	Treatments							
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01	$0.22^{k}\pm$ 0.01
3	$0.45^{l}\pm$ 0.02	$0.41^{ij}\pm$ 0.02	$0.40^{ij}\pm$ 0.03	$0.38^{j}\pm$ 0.01	$0.42^{ij}\pm$ 0.01	$0.40^{ij}\pm$ 0.02	$0.38^{j}\pm$ 0.03	$0.36^{j}\pm$ 0.02
6	$0.68^{gf}\pm$ 0.03	$0.64^{efgh}\pm$ 0.02	$0.64^{efgh}\pm$ 0.01	$0.61^{gh}\pm$ 0.04	$0.65^{efg}\pm$ 0.03	$0.62^{fgh}\pm$ 0.03	$0.61^{gh}\pm$ 0.01	$0.58^{h}\pm$ 0.01
9	$0.96^{a}\pm$ 0.01	$0.80^{bc}\pm$ 0.01	$0.78^{bc}\pm$ 0.03	$0.75^{cd}\pm$ 0.03	$0.82^{b}\pm$ 0.02	$0.77^{bc}\pm$ 0.02	$0.75^{cd}\pm$ 0.02	$0.70^{de}\pm$ 0.02

a,b,c....Means values in each column having different superscript are significantly different at (P< 0.05).

BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic acid

Moreover, addition of 1000 ppm of BA or SA to unpasteurized samples at 9 storage days or BA plus SA mixture at 6 or 9 storage days were significantly (P< 0.05) decreased of TBA compared to control treatments. Also, addition of 1000 ppm of SA or BA plus SA mixture to pasteurized samples were significantly (P< 0.05) decreased of TBA at 9 storage days only compared to control treatrnent. Similar results obtained by Abu-Salem and Khalaf (1988); Estevez and Cava (2004)

Who reported that there were increases in TBA by increasing of storage periods of chicken meat products and pigs. Also, *Gray and Monahan (1992)* recommended that mixing of ground buffalo meat with 600 ppm

sodium ascorbate plus 5 ppm α -tocopherol acetate for lowering TBA up to six days of refrigerated storage. Presumably, adding BA+SA mixture to chicken liver paste (Foie gras) and pasteurized the product at 85°C could be recommended for lowering TBA values and hence for inhibiting lipid oxidation as well as preventing rancidity to an extent up to nine days of refrigerated storage (4°C).

Data in Table 3 showed that, Total volatile nitrogen (TVN) increased significantly (P< 0.05) in different treatments as storage periods increased. Conversely, TVN decreased significantly (P< 0.05) at 6 or 9 storage days in different samples pasteurized at 85°C compared with unpasteurized treatments.

Table (3): Changes in TVN (mg/100g)) of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized during storage periods

	Treatments							
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0.01	$3.20^{r}\pm$ 0 01	$3.20^{r}\pm$ 0.01
3	$4.85^{l}\pm$ 0.01	$4.65^{mn}\pm$ 0.01	$4.63^{mn}\pm$ 0.03	$4.50^{op}\pm$ 0.03	$4.75^{lm}\pm$ 0.01	$4.60^{on}\pm$ 0.03	$4.41^{p}\pm$ 0.02	$4.03^{q}\pm$ 0.02
6	$6.85^{i}\pm$ 0.02	$6.42^{g}\pm$ 0.02	$6.40^{g}\pm$ 0.02	$6.01^{j}\pm$ 0.01	$6.42^{g}\pm$ 0.03	$6.02^{j}\pm$ 0.03	$5.52^{k}\pm$ 0.02	$5.12^{k}\pm$ 0.02
9	$8.25^{a}\pm$ 0.03	$7.99^{b}\pm$ 0.03	$7.60^{c}\pm$ 0.03	$7.02^{d}\pm$ 0.02	$8.02^{b}\pm$ 0.01	$7.03^{e}\pm$ 0.03	$6.85^{f}\pm$ 0.01	$6.18^{h}\pm$ 0.02

a,b,c... Means values in each column having different superscript are significantly different at (P< 0.05).

BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic acid

Moreover, addition of 1000 ppm of BA, SA or BA plus SA mixture to unpasteurized or pasteurized samples at 3, 6 and 9 storage days were significantly (P< 0.05) decreased of TVN compared to its control treatments. Also, addition of BA plus SA mixture to different treatments 3, 6 and 9 storage days were significantly (P< 0.05) decreased of TVN as compared to addition of BA or SA. This finding are in accordance with *Abu-Salem and Khalaf (1988)* who reported that increase in TVN by increasing of storage time with chicken meat products. Such results agree with those reported by *Pearson et al., (1976); Demyer and Vandekevchkove (1979).* TVN is an index to the degree of putrification and breakdown of proteinaceous constituents (El-Saaid Basuni, 1993). *Abu-Salem and Khallaf (1988)* reported that the increase in TVN during frozen storage due to the breakdown of proteins. Such protein decomposition could be due to the microbial activity. It could be also noticed that protein hydrolysis and microbial breakdown were responsible for this increase. These results would suggest that adding of BA plus SA and pasteurized the product at 85 °C for decreasing TVN in products.

A significantly (P< 0.05) increased Peroxide value (PV) due to the storage periods at 4°C with treated or untreated samples (Table 4). In contrast, PV decreased significantly (P< 0.05) at 3, 6 or 9 storage days in different samples pasteurized compared with unpasteurized treatments. Also, adding 1000 ppm of BA, SA or BA plus SA mixture to unpasteurized or pasteurized samples at 3, 6 and 9 storage days were significantly (P< 0.05) decreased of PV compared to its control treatments. A significantly (P< 0.05) were detected due to BA plus SA mixture compared with either BA or SA. Generally, the depression of PV was in the following order: BA plus SA mixture followed by SA and then BA or the significantly reduction of PV was more profound due to adding BA plus SA mixture to chicken liver paste. It could be recommended that mixture of BA plus SA to decreasing PV, especially with the pasteurization at 85°C.

Table (4): Changes in PV (mg/kg extract fat) of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized during storage periods

Treatments								
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$	$1.50^{t} \pm 0.00$
3	$2.90^{n} \pm 0.02$	$4.40^{p} \pm 0.02$	$2.35^{o} \pm 0.03$	$2.25^{q} \pm 0.02$	$2.82^{o} \pm 0.02$	$2.25^{q} \pm 0.02$	$2.18^{r} \pm 0.03$	$2.01^{s} \pm 0.01$
6	$4.25^{g} \pm 0.02$	$4.02^{i} \pm 0.02$	$3.95^{j} \pm 0.02$	$3.75^{l} \pm 0.01$	$4.02^{i} \pm 0.02$	$3.85^{k} \pm 0.01$	$3.70^{l} \pm 0.03$	$3.55^{m} \pm 0.03$
9	$5.60^{a} \pm 0.01$	$5.00^{c} \pm 0.01$	$4.85^{d} \pm 0.02$	$4.50^{f} \pm 0.02$	$5.25^{b} \pm 0.02$	$4.75^{e} \pm 0.02$	$4.55^{f} \pm 0.02$	$4.18^{h} \pm 0.03$

a,b,c... Means values in each column having different superscript are significantly different at (P< 0.05).
BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic acid

Inspection of data in Table 5 shows that, a significant (P< 0.05) increased free fatty acids (FFA) was detected due to the storage periods at 4°C with all different treatment. In contrary, FFA decreased significantly (P< 0.05) at 6 or 9 storage days in untreated and at 9 in treated samples pasteurized compared with unpasteurized treatments. Also, adding 1000 ppm of BA, SA or BA plus SA mixture to unpasteurized or pasteurized samples at 3, 6 and 9 storage days were significantly (P< 0.05) decreased of FFA compared to its control treatments. Generally, a significantly (P< 0.05) were detected due to BA plus SA mixture at 9 storage days in unpasteurized or at 6 or 9 storage days in pasteurized treatments compared with either BA or SA. The depression of FFA was in the following order: BA plus SA mixture followed by SA and then BA or the significantly reduction of FFA was more profound due to adding BA plus SA mixture to chicken liver paste. These finding are in agreement with *Abu-Salem and Khalaf (1988)* who reported that increase in FFA of chicken meat products by increasing of storage time. Also, *Fishwish (1968)* found that FFA increased during storage of 0, -3, -10 and –20°C indicating lipolytic changes. This increasing could be due to fat

hydrolysis and enzymatic oxidation of fatty acids by microorganism, as stated by *Branen (1979)*. It could be recommended that mixture of BA plus SA to decreasing FFA especially with the pasteurization at 85°C.

Table (5): Changes in Free fatty acid (FFA) as oleic acid of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized during storage period

Treatments								
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$	$0.25^{b} \pm 0.00$
3	$0.50^{j} \pm 0.02$	$0.45^{lm} \pm 0.02$	$0.42^{mn} \pm 0.02$	$0.40^{mno} \pm 0.02$	$0.48^{l} \pm 0.02$	$0.42^{mn} \pm 0.02$	$0.38^{no} \pm 0.02$	$0.35^{o} \pm 0.01$
6	$0.98^{f} \pm 0.01$	$0.85^{h} \pm 0.01$	$0.80^{hij} \pm 0.01$	$0.76^{ij} \pm 0.02$	$0.90^{g} \pm 0.03$	$0.81^{hi} \pm 0.01$	$0.75^{j} \pm 0.01$	$0.68^{k} \pm 0.03$
9	$1.35^{a} \pm 0.02$	$1.26^{b} \pm 0.03$	$1.24^{bc} \pm 0.02$	$1.18^{d} \pm 0.02$	$1.25^{bc} \pm 0.02$	$1.20^{cd} \pm 0.02$	$1.18^{d} \pm 0.02$	$1.12^{e} \pm 0.02$

a,b,c..... Means values in each column having different superscript are significantly different at (P< 0.05).
BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic acid

Data in Table 6 showed significant (P< 0.05) increases ammonia contents as a result of storage periods at 4°C in all different treatments. However, storage pasteurized product had significantly (P< 0.05) decreased in ammonia contents at 3, 6 or 9 storage days compared with unpasteurized treatments. Moreover, storage products, pasteurized or unpasteurized, mixed with 1000 ppm of BA, SA or BA plus SA mixture, resulted in a significant (P< 0.05) decreases in ammonia contents at 3, 6 or 9 storage days compared with unmixed control products.

Table(6): Changes in ammonia content (mg/100g) of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized during storage periods

Treatments								
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$	$1.82^{m} \pm 0.00$
3	$1.99^{j} \pm 0.02$	$1.81^{m} \pm 0.01$	$1.80^{mn} \pm 0.02$	$1.75^{no} \pm 0.01$	$1.85^{m} \pm 0.02$	$1.75^{no} \pm 0.02$	$1.70^{o} \pm 0.03$	$1.61^{p} \pm 0.02$
6	$2.83^{g} \pm 0.03$	$2.75^{hi} \pm 0.01$	$2.70^{i} \pm 0.02$	$2.75^{hi} \pm 0.03$	$2.80^{gh} \pm 0.01$	$2.60^{j} \pm 0.03$	$2.58^{j} \pm 0.03$	$2.42^{k} \pm 0.01$
9	$4.20^{a} \pm 0.02$	$4.05^{b} \pm 0.02$	$3.95^{c} \pm 0.02$	$3.90^{c} \pm 0.01$	$4.09^{b} \pm 0.01$	$3.80^{d} \pm 0.03$	$3.70^{e} \pm 0.03$	$3.45^{f} \pm 0.02$

a,b,c... ..... Means values in each column having different superscript are significantly different at (P< 0.05).
BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic

These results indicate the breakdown of protein by proteolysis. The bacterial action on protein may lead to formation of ammonia. Similarly, *Abu-Salem and Khalaf (1988)* who showed that ammonia content in chicken meat products increased by increasing of storage time. Such results agree with those reported by *Demyer and Vandekevchkova (1979), El-Deep (1983),* and *Salem et al. (1985).*

Lipid oxidation of chicken liver paste was also measured using saponification value(SV). Data in Table 7 showed significant (P< 0.05) increases SV as a result of storage period at 4°C. Similar results reported by *Abu-Salem and Khalaf (1988).* These results are due to the hydrolysis of triglycerides and phospholipids by lipases and phospholipases (*Aman and Smirnova, 1970*). These values did not affected with various treatments. Addition of 1000 ppm of BA or SA or mixture of 500 ppm of both with or without pasteurization did not effect on the SV.

Table (7): Changes in Saponification value of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized during storage periods

Treatments								
	Unpasteurized				Pasteurized			
Storage period (day)	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	Control	BA 1000 ppm	SA 1000 ppm	SA+BA 500 ppm of both
0	$150.3^{y} \pm 0.01$	$150.3^{y} \pm 0.01$	$10.30^{y} \pm 0.01$	$10.30^{y} \pm 0.01$	$10.30^{y} \pm 0.01$	$150.3^{y} \pm 0.01$	$10.30^{y} \pm 0.01$	$10.30^{y} \pm 0.01$
3	$152.8^{p} \pm 0.03$	$151.7^{q} \pm 0.03$	$151.61^{r} \pm 0.01$	$151.5^{s} \pm 0.02$	$152.7^{p} \pm 0.03$	$151.60^{r} \pm 0.04$	$151.21^{t} \pm 0.01$	$10.85^{u} \pm 0.03$
6	$158.3^{g} \pm 0.03$	$157.02^{i} \pm 0.02$	$156.80^{j} \pm 0.02$	$154.9^{n} \pm 0.02$	$158.00^{f} \pm 0.02$	$155.92^{l} \pm 0.02$	$155.93^{l} \pm 0.03$	$154.0^{o} \pm 0.04$
9	$160.4^{a} \pm 0.02$	$159.3^{c} \pm 0.03$	$158.1^{e} \pm 0.01$	$156.2^{k} \pm 0.02$	$159.8^{b} \pm 0.01$	$157.4^{g} \pm 0.03$	$157.3^{h} \pm 0.03$	$155.3^{m} \pm 0.03$

a,b,c,... ..... Means values in each column having different superscript are significantly different at (P< 0.05).
BA: Benzoic acid SA: Sorbic acid BA + SA: Benzoic acid plus Sorbic acid

Microbiological evaluation:

Off odors and softness of meat texture was noticed by action of microbial enzymes. Microorganisms spoilage caused a breakdown of protein, lipids, pigments and carbohydrates (*Schaefer,2002*).The effect of different levels of weak acid preservatives (benzoic acid and sorbic acid) with or without pasteurization to control common micro-organisms causing spoilage of chicken liver paste (Foie gras) was studied and the data presented in Table 8. A treated or untreated samples was free from *coliform, Staphylococcus aureus, and Salmonella,* which was an index of good sanitory conditions created during processing. On the other hand aerobic bacteria, mold, and yeast were detected at levels 10^4, 10^2, and 10 c.f.u/g,respectively in control sample at zero time. After nine days of storage at 4 °C, the microorganisms increased which recorded 10^5, 10^4, and 10^3 with aerobic bacteria, mold, and yeast, respectively. The addition of 1000 ppm of BA or SA or the mixture of 500 ppm of both BA plus SA decreased the levels

of micro-organisms and these effect increased with the pasteurization at 85 °C. This findings indicate that 500 ppm of both BA plus SA with or without pasteurization may be a suitable preserving agent to inhibit deterioration of chicken liver paste (Foie gras). Organic acids have been used for years due to availability, ease of use and low cost. Both benzoic and sorbic acid have a broad spectrum of activity (*Nielsen and de Boer, 2000; Davidson, 2001*). Benzoic acid and sodium benzoate are most commonly used to prevent growth of yeast's and molds (*Deis, 2002; Davidson and Harrison, 2002*). In fact, however, bacteria are quite variable in their resistance to benzoate. Benzoate are used primarily as antifungals because: (1) they function best in the undissociated state, which is the predominant from of the compound at low pH in high acid foods; and (2) fungi are the primary spoilage microorganisms in acidic foods. Therefore, the innate resistance of yeast's and molds to benzoate is of greater concern than that of bacteria (*Davidson and Harrison, 2002*). Sorbic acid is widely used to inhibit yeast and mould growth and selected bacteria in a variety of foods (*FDA, 2002*). The minimum inhibitory concentration for many fungi and bacteria are approx. 100 ppm and the common usage levels range from 0.5-1.0 % (*FDA, 2002*). Besides, pasteurization of the meat destroys vegetative pathogenic reduces spoilage microorganisms to very low levels. Further studies have to be done in order to adjust the minimum inhibitory concentration necessary to obtain a product with the required shelf life. *El-Moueffak et al., (1995)* reported that a pasteurization type effect (drastic reduction of vegetative mesophilic and psychrophilic contamination's, destruction of *Coliforms*, and *Staphylococcus aureus*) was obtained at 50°C with the samples of duck Foie gras pasteurized at 400 MPa for at least 10 min.

Table (8): Microbiological analysis (c.f.u/g) of chicken liver paste (Foie gras) preservative by benzoic and /or sorbic acid and pasteurized at 85 °C or unpasteurized after 9 days of storage period

Treatments							
	Unpasteurized				Pasteurized		
Item*	Control	BA 1000 ppm	SA 1000 ppm	BA+SA 500 ppm of both	BA 1000 Ppm	SA 1000 ppm	SA+BA 500 ppm of both
Aerobic bacteria (AB)	10^5	10^4	10^4	10^3	10^2	10^2	10^2
Total coliform	-	-	-	-	-	-	-
Staphylococcus aureus	-	-	-	-	-	-	-
Salmonella	-	-	-	-	-	-	-
Mold	10^4	10^3	10^2	10	10^2	10	10
Yeast	10^3	10^2	10^2	10	10	10^2	10

* Counts c.f.u/g

Zero time :	AB	Mold	Yeast
-control	10^4	10^2	10
-1000 ppm BA	10^3	10	10
-1000 ppm SA	10^3	10	10
-500 ppm of both	10^2	10	10

On the other hand, *Zuber (1996)* showed that pasteurization of Foie gras at 60-100 °C resulted in *Coliform, Staphylococcus aureus, and Salmonella* absence. However, microorganism aerobic was 10^4/g in pasteurized. Potassium sorbate was found to be the most effective in preventing fungal spoilage of bakery products at the maximum concentration (0.3%) tested (*Guynot et al., 2005*). In addition, *Okolocha and Ellerbroek (2005)* reported that acids (1% lactic acid or/and ascorbic acid) are viable tools for the decontamination *(Enterobacteriaceae, Pseudomonas, and Lactobacillus)* of poultry carcasses.

3- Sensory evaluation:

Sensory evaluation showed that, liver paste from chicken were very much acceptable from the standpoint of taste, odor, appearance, color and texture. Wherefore, statistical analysis proved that no significant differences observed between liver paste (Foie gras) from chicken or duck (Table 9). The panelists reported that taste and flavor of Foie gras from both chicken and duck livers were delicate, and strong as well as rich aroma. Appearance and texture were homogenized and creamy in both Foie gras. The color was ivory white in duck Foie gras and yellow in chicken Foie gras. At its best, it is a delicate rosy color with mottling of beige. The flavor is extraordinarly rich and the texture silky smooth (*Epicurious Food Dictionary, 1995*).

Table(9): Sensory evaluation of liver paste (Foie gras) manufactured from chicken liver compared with liver paste from duck liver

Type	Taste	Odor	Appearance	Color	Texture	Overall acceptability
Chicken liver	$8.6^a \pm 0.31$	$8.5^a \pm 0.28$	$8.8^a \pm 0.21$	$8.5^a \pm 0.26$	$8.8^a \pm 0.32$	$8.8^a \pm 0.20$
Duck liver	$9.0^a \pm 0.21$	$8.8^a \pm 0.37$	$9.1^a \pm 0.16$	$9.0^a \pm 0.29$	$9.0^a \pm 0.21$	$9.0^a \pm 0.21$

Means of scored according to 10- point hedonic scale (10-9) = very good, (1-0) =very poor

Conclusion

It could be concluded that, liver is an economic and rich source of essential nutrients like protein, iron and zinc. Liver paste (Foie gras) from chicken liver were rich in protein and fat (from butter) as well as different minerals, such as Fe, Zn, Cu, and Mn. Presumably, mixing of liver paste (Foie gras) from chicken liver with 500 ppm of both benzoic acid plus sorbic acid and pasteurized the product at 85°C could be recommended for lowering TBA, TVN, PV, FFA, ammonia, SV and hence for inhibiting lipid oxidation and preventing rancidity to an extent up to nine days of refrigerated storage at 4°C. This level may be also a suitable preserving agent to inhibit bacterial deterioration of chicken liver paste (Foie gras). Sensory evaluation showed that, liver paste from chicken liver were very much acceptable. Wherefore, statistical analysis proved that no significant differences observed between Foie gras from chicken or duck liver.

REFERENCES

Abou-Arab, A A.K. (2001). Heavy metal contents in Egyptian meat and the role of detergent washing on their levels. J. Food and Chemical Toxicology, 39, 593- 599.

Abu-Salem, F. M. and H. H. Khalaf. (1988). Changes of microbiological and chemical properties of chicken meat products (fine chest, sausage and luncheon) during frozen storage at (-18 °C) for 10 months. Ann. Agric.; Moshtohor, 26 (4): 2617-2626.

Abu-Salem, F. M. and H. H. Khallaf. (1988). Preservation of chicken fat at low tempearature in presence of antioxidants. Annals Agric. Sci. Fac. Agric.; Ain Shams. Cairo, Egypt. 33 (2): 115-1130.

Aman, M.E. and G.A. Smirnova. (1970). Studies on the lipids of pike muscles by TLC. J. Alex. Agric. Res., 26:197-205.

A.O.A.C. (1995). Official Methods of Analysis". A.O.A.C..International, Suite 400 2200 Wilson Boulevard Arlington, Virginia, 2201-3301, USA.

APHA. (1992). American Public Health Association Compendium of Methods for the Microbiological Examination of Foods. APHA, pp.7-97, 239-250, and 325-422.

Blum, P.J.C. (1997). "Foie gras" Development in birds: physiological and biochemical characteristics. Acad. Agric. Fr.; 83, pp. 101-115.

Branen, A.L. (1979). Interaction of fat oxidation and microbial spoilage in muscle foods. Food Sci., & Tech., 156-161.

Davidson, M.P. (2001). Chemical preservatives and antimicrobial compounds. In Food microbiology: Fundamentals and frontiers. Edited by M.P. Doyle, L.R. Beuchat & T.J. Montville, pp. 593-627. ASM Press Washington, USA.

Davidson, M.P. and M.A. Harrison (2002). Resistance and adaptation of food antimicrobials, sanitizers, and other process controls. Food Tech.56(11).

Deis, R.C. (2002). The complexity of shelf-life stability. Food Product Design, February 2002.

Demyer, D.I. and P. Vandekevchkove. (1979). Compounds determining pH in dry sausage. Meat Sci., 3 (3): 161-167.

El-Deep, S.H. (1983). Food quality as determined y metabolic by-products of microorganisms. M.Sc. Thesis, Fac. of Agric., Ain Shams Univ., Egypt.

El-Moueffak, A.H.; C. Christian.; M. Antoine.; M. Montury.; G. Demazeau.; A. Largeteau.; B. Roy and F. Zuber. (1995). High pressure and pasteurization effect on duck Foie gras. International J. of Food Sci., & Tech., (30): 737-743.

El-Saaid Basuni, S.S. (1993). Chemistry and technology of fish preservation and processing. "Book', 35-207, Published by Faculty of Agric., Zagazig Univ.,
A.R.E. (In Arabic).

Epicurean Com. (2005). Chicken liver paste (pate de foie gras) Recipe. Epicurean Com for food and wine lovers, 15/10/2005.

Epicurious Food Dictionary. (1995). The food lover's companion. Foie gras. Epicurious Food Dictionary, Copyright Barron's Educational Services,Inc., 1995.

Estevez, M. and R. Cava. (2004). Lipid and protein oxidation, release of iron from heme molecule and colour deterioration during refrigerated storage of liver pàtè. Meat Sci., 66: 551-558.

FDA. (2002). Food and Drug Administration. Department of Health and Human Services. Part 582-Substances generally recognized as safe-chemical preservatives. Sec. 582-3640.

Fishwish, M.J. (1968). Changes in lipids of turkey muscle during storage at chilling and freezing temperature. J. of the Sci., of Food and Agric., 19 (8): 440-445.

Gray, J.I. and F.T. Monahan. (1992). Measurement of lipid oxidation in meat and meat products. Trends Food Sci., Tech., 3:315-319.

Guy, G.; P.D. Rousselot and D. Gourichon. (1991). Comparison des performances quantitativees et qualitatives due gavage de l'oie, du canard mulard et du canard de Barbarie. Jounees de recherches avicoles, Tours, 28 April 1993, 99-105, INRA Station de Recherches Avicoles, Nouzilly.

Guynot, M.E.; S. Marin.; V.Sanchis and A.J. Ramos. (2005). An attempt to optimize potassium sorbate use to preserve low pH (4.5-5.5) intermediate moisture bakery products by modelling *Eurotium spp., Aspergillus spp.* and *Penicillium corylophilum* growth. International J. of Food Microbiology, Vol.101, Issue 2. P.169-177.

Hecht, H. (1996). Copper in the muscles and livers of calves and other mammals. Fleischwirtschaft. 76, 492-494.

Jorhem, L.; P. Matterson and S. Slorach. (1984). Lead, cadmium, zinc and certain other metals in foods on the Swedish Market. Var Föda, 36 (suppl.3), 139-208.

Mavromichalis, I.; J.L. Emmert; S. Aoyagi and D.H. Baker. (2000). Chemical composition of whole body, tissues and organs of young chickens (Gallus domesticus). J. of Food Composition and Analysis, 13: 799-802.

Nielsen, P.V and E.de Boer. (2000). Food preservatives against fungi. In Introduction to food and airborne fungi. Edited by R.A. Samson, E.S. Hoekstra, J.C. Frisvad & O. Fittenborg. Pp. 357-363. Centraallureau Voor Schimunelcultures. Utrecht,
The Netherlands.

Okolocha, E.C. and L. Ellerbroek. (2005). The influence of acid and alkaline treatments on pathogens and the shelf life of poultry meat. Food Control, Vol. 16, Issue 3, p. 217-225.

Pearson, D. (1976). The Chernical Analysis of Foods. 7Th ed. Churchil Livingston: Edinburgh, London, N.Y.

Salem, F.A.; A.A. Askar.; H.K.El-Manawaty.; A.I. Khazbak. and A.A. El-Dashlouty. (1985). Effect of nitrate level on the chemical and microbiological properties of sausage during storage. Egypt. J. Food Sci., 13 (1): 49-56.

Salichon, M.R.; G.Guy.; D. Rousselot and J.C. Blum. (1994). Composition of the 3 types of Foie gras: goose, mule, duck and muscovy duck Foie gras. Ann Zootech., 43; 213-220.

SAS. (1998). SAS/STAT user's Guide Release 6.03 edition. SAS Institute Inc., Cary, Nc, USA.

SCAH. (2005). Scientific Committee on Animal Health and Animal Welfare. Welfar Aspects of the production of foie gras production. Report of the Scientific Committee on Animal Health and Animal Welfare, 10/12/2005.

Schaefer, D.M. (2002). Fresh beef marketing opportunities due to dietary vitamin E. National Cattle men's Beef Association and the Cattlemen's Beef Board.

Sola, S.; T. Barrio and A. Martin. (1997). Essential elements (Mn, Fe, Cu, Zn) in pork and duck liver paste produced in Spain. Food Additives and Contaminants, vol. 14 (2): 135-141.

Zuber, F. (1996). La pasteurization des Foie gras. Viandes Prod. Carnes, Vol. 17 (4):151-156.

الخواص الكيميائية و الجودة الميكروبيولوجية و التقييم الحسى لعجينة كبد الدواجن والبط (فوجراه)

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عجينه الكبد (فوجراه) هو مصطلح فرنسي يعنى" الكبد الدهني" و يتم صناعته من كبد الأوز والبط ويمكن صناعته أيضا من كبد الدجاج وهذه الدراسة توضح صفات وجودة كبد الدجاج والبط الخام بالمقارنة مع عجينه الكبد (فوجراه) المصنعة. وقد أوضحت نتائج البحث المتحصل عليها أن:

١- كبد الدواجن الخام تحتوى على ٢٤ر٦ % بروتين و ٦ر. % دهن و ١ر٤ % رماد و٦٦ر٨ % رطوبة.

٢- متوسط قيم العناصر المعدنية كانت ٨٣ر٦٥ و٧٥ر٥٠ و ٢٩ر٥ و ١٥ر١ و ١٥٤ر٠ و ٦٨٣ر٠ و ٣١٧ ر. و ٠٦٦ر٠ ميكروجرام /جرام وزن رطب لكل من الحديد والزنك والنحاس والمنجنيز والكادميوم والرصاص والنيكل والكروم على التوالي.

٣- عجينه كبد الدواجن تختلف في تركيبها الكيماوي عن الكبد الخام نتيجة فقد الرطوبة أثناء الطبخ وفقد جزء من دهن الكبد و إضافة الزبد لرفع نسبة الدهن. وقد كانت مكونات المنتج على النحو التالي: ٨ر٢٧ % رطوبة - ١ر١٠ % بروتين - ٢ر٥٨ % دهن - ٨ر. % رماد. أما العناصر المعدنية فكانت تركيزاتها ٩٠ر٦٨ و ٥٠ر٤٠ و ٦ر١ و ١ر١ و ٨ر. و ٢٢ر. و ٤ر. و ٤ر. ميكروجرام/ جرام وزن رطب لكل من الحديد والزنك والنحاس والمنجنيز والكادميوم والرصاص والنيكل والكروم على التوالي.

وقد تم عمل تقييم كيماوي وميكروبيولوجى وحسي لعجينة كبد الدواجن (فواجراه) المصنعة من الكبد الخام تحت ظروف حفظ مختلفة باستخدام ١٠٠٠ جزء/ المليون من حمض البنزويك أوحمض السوربيك وخليط بتركيز ٥٠٠ جزء/ المليون من كل من حمض البنزويك والسوربيك مع بسترة المنتج على درجة حرارة ٨٥ °م أو بدون بسترة وحفظ عجينه الكبد على درجة حرارة ٤°م لمدة ٩ أيام وأوضحت النتائج أن:-

١- خلط عجينه كبد الدواجن بـ ٥٠٠ جزء/المليون من كلا من حمض البنزويك وحمض السوربيك مع بسترة المنتج على ٨٥ °م أدى الى خفض محتوى كل من حمض الثيوباربتيوريك والنيتروجين الكلى المتطاير ورقم البيروكسيد والأحماض الدهنية الحرة والأمونيا ورقم التصبن وبالتالى منع حدوث تأكسد الدهن ومنع التزنخ حيث أن كل هذه الاختبارات دلائل كيماوية على قدرة حفظ المنتج والتى تزيد عن ٩ أيام على درجة حرارة ٤°م دون حدوث فساد للمنتج وهذه المستويات أيضا كافية لتثبيط نشاط الميكروبات المسببة للفساد.

٢- أثبتت نتائج التقييم الحسى لعجينة كبد الدواجن أن هذا المنتج جيد جدا لمدى قبوله لدى المستهلك من حيث الطعم والرائحة واللون والتركيب والمظهر كما أثبتت نتائج التحليل الإحصائي أنه لا يوجد فروق معنوية بين هذا المنتج ومثيله المصنع من كبد البط.