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SMOKING OF RABBIT MEAT AS HEALTHY PRESERVATION

Abd El-Halim,A. A.
Meat & Fish Technol. Res. Dept. Food Technol. Res. Institute, Agric. Res. Center, Giza, Egypt.

ABSTRACT

Rabbit meat is characterized by its higher protein, polyunsaturated fatty acids, lower energetic value and cholesterol due to its relatively low fat content, rabbit meat might be aid in preparation of new products. In the present work, rabbit meats was used in processing of smoked rabbit meats with liquid and hot smoking's. Smoked rabbit with different smoking methods were stored at cold storage 4C^{o} for 15 days and frozen storage -18C^{o} for 90 days. Chemical composition, chemical and physical properties, and evaluation of fatty acids composition were determined raw and meats smoked immediately after processing and during storage periods. It could be noticed that rabbit meat had higher quality compared with smoked rabbit tested just after processing. Smoked rabbit meat with liquid smoke had the highest levels of chemical composition and functional properties compared with smoked rabbit meats with hot smoking. Cold storage of smoked rabbit negatively affect those chemical composition and functional properties compared with stored at -18C^{o}.

INTRODUCTION

Rabbit meat could be a useful food in human dietetics. It is higher in protein, relatively lower in fat, sodium and cholesterol than most other meats Rao, *et al., (*1978). The thiobarbituric acid (TBA) assay is the most popular method of measuring oxidative deterioration of lipids (Sinnhuber andYu, (1977) and Pearson, *et al.*, (1983). The TBA assay has been highly correlated with sensory evaluation scores for oxidized and warmed –over flavor in muscle foods (Wilson, *etal.,* 1976). Drying many enhance oxidation and rancidity and there by causes a slight reduction in protein quality. The degree to which drying adversely affect protein quality depends on the drying time. Whenever possibly, drying should be conducted between 70 to 80C or at lower temperature so that heat damage to protein quality is negligible. Drying at higher temperatures, ie 115 C or higher should be avoided because of its profound negative effects on protein quality (Rehbein, 1992).

Rabbit meat has a higher protein (20-21%), lowcalories(1749 Kcal/Kg), low fat content(10-11%), low cholesterol value(169 mg/100g of dry matter basis) and low sodium content when compared with meat from most livestock species(Janieri,1987).

Fatty acids (FAs) are not only important substrates for energy production in exercise, but particularly polyunsaturated ones, are also susceptible to per oxidative damage in the presence of oxygen free radicals (Halliwell, 1992). Consequently the rate of oxygen free radical formation play an important role in the process of lipids peroxidation. On the hand, the FA composition of lipids modifies their susceptibility to oxidation damage (Mezes, *et al;* 1998).

Brandt (2001) reported that using liquid smoking as GRAs, generally recognize as safe, ingredients in smoking of food product is required because liquid smoke has many advantages including ; Removing the potentially harmful compounds before it is blended with food , applying to a wide variety of foods that traditionally are not smoked, using it on the consumer and commercial processing scale , reducing the cost and production time of smoked food , less environmental pollution , controlling of flavor and color of smoked product and it can be applied in various ways (versa stability) such as spraying , dipping , injection and actual mixing with food. Combes,(2004) studied the nutritional value of rabbits meat and he found that for rabbits at commercial slaughtering age and weight ,protein 21.0+ 1.5 %, water 72.5 +2.5% and total mineral1.2+ 0.1% w.w,main variations in the lipids contents 5+3.3% on w.w) mainly originate from anatomical area and diet . Cholesterol content of 59 mg/100g and a ratio omega 6/ omega 3 of 59mg make rabbit meat attractive for health purposes. Rabbit meats is highly valued for its nutritional and dietary properties; it is a lean meat with a low fat content and less saturated fatty acids and cholesterol than other meats(Lombardi-Boccia,*et al*.,(2005);Hernandez and Gondret,(2006);Pla,*et al*.,(2007) and Hernandez,(2008)). Rabbit meat is characterized by its lower energetic value compared with red meat (DalleZotte, 2004) due to its low fat content. Fatty acids composition of rabbit meat is characterized by high polyunsaturated fatty acids content (Hernandez and Gondret, 2006).The aim of this study is produce new products from rabbit meats and examinf the effects of different smoking methods and storage periods on functional properties and fatty acids composition.

MATERIALS AND METHODS

A-Materials:

Male rabbit was obtained from the local market in Qaluobia (about 2000g) in weight, after slaughtered. The head, skin and internal organs were removed, then the carcasses were rapidly washed with tap water several time. After that, the excess water drained, the meat of the whole carcasses was separated. Whole rabbit meat was smoked using liquid and hot smoking according to the following steps:

B- Methods:

Preparation of the liquid smoking:

Liquid smoke was prepared according to Moghazy (1994) as follows: Hard wood sawdust (Zan) was used to generate smoke; temperature used in generated was condensed through a water condenser and collected in a collection flask. Whole smoke condensate was filtered through whatman paper No.1 three times, centrifuged at 4000 rpm for 15 minutes, stored at $4C^{o}$ for 30 days to remove any residual of tar substance and there after adjusted to pH 4 using sodium bicarbonate

Liquid smoking in rabbit:

1-Washing rabbit meat with tab water.

2- Salting rabbit was carried out in saturated sodium chloride solution for 8 hr. at $4C^{o}$.

3-The salted rabbit was desalted using tap water in a ratio of 1:1W.W for 1-2hr. to remove the excessive salt on the surface only.

4-Partial drying for one hr. at 50C^{o} was achieved immediately after desalting process.

5-Smoking with liquid smoke was applied where the partial dried rabbit were treated with the prepared liquid smoke and repeating spraying on the surfaces of whole rabbitpresented insmoke house controlled at 90C^{o}, while the temperature of smoking itself was 70C^{o} and the treatment cycle was repeated at least 20 times and the time between each treatment and other was about 5 minutes. At the end of smoking, the liquid smoked rabbit had pleasant color and flavor.

Hot smoking in rabbit:

The same technique of liquid smoking was applied for hot smoking replacing the smoke liquid with traditional smoke house. Hard wood sawdust (beech zany wood) was used to generate smoke. Smoking temperature was 90C^{o} while smoking time was 2.5 hr. to obtain golden yellow color of hot smoking. The smoked rabbit were cooled at room temperature, packaged in polyethylene bag and stored at 4C^{o} for 15 day and -18C^{o} for 3 months.

After processing smoking of rabbit as well as during storage at 5 days intervals for smoked samples stored at 4C^{o} while samples stored at -18C^{o} were analyzed after 30, 60 and 90 days storage.

Storage and analysis of rabbit meat and products

The analysis was carried out before as raw rabbit and after as smoked rabbit, immediately.as well as during storage periods. Rabbit flesh was mined and thoroughly mixed using an electric mixer before carrying out the following analysis

1-Some physic- chemical properties:

A-The moisture, protein, fat and ash, were determined according to the methods described in the **A.O.A.C. (1995).**

B- **Determination of thiobarbituric acid (T.B.A.):**

Thiobarbituric acid value (T.B.A.) as an indicator of fat oxidation was determined as mentioned **by Pearson (1970)**Optical density value at 538nm was multiplied by 7.8 to obtain the content of malonaldehyde as mg/kg sample.

C-Total volatile nitrogen (TVN):

Total volatile nitrogen (TVN) as indicator of the quality was determined according to the method published by **Winton and Winton (1958).**

D- Water holding capacity (WHC) and plasticity of meats were measured using the method of **Soloviuskaia and Merkodlovia, (1958)**

E- Roasting loss% of samples was calculated as a percentage of weight change from raw to cooked state **(El-Nemer, (1979).**

$$\textbf{Roasting loss\%} = 100 - \frac{\textbf{Cooked-sample weight}}{\textbf{Un cookedsample weight}} \times 100$$

F- Ks and Du value:

Ks and Du value indicating the rate of lipids oxidation were calculated according to Semyonov,*et al*; (1979) as follow

Ks=%total unsaturated fatty acids/%total saturated fatty acids
Du= 1(mono. Un- saturated fatty acids)+2(di-unsaturated fatty acids) +3(tri. Un-saturated fatty acids).
G- Phenol determination:
The phenolic compound was determined according to the method of, Chan, *et al* (1975).

Extraction of total lipid

The method of Bligh and Dyer(1959) was used for the extraction of rabbit lipids each 100gm of minced sample was homogenized in a warring blender for 2 min. with a mixture of 100ml of chloroform, 200ml. of methanol and 5ml of distilled water to a give a ratio of 1:2:0.8.To the mixture,100ml. of chloroform was added and after blending for 30 second, 100ml of distilled water were mixed to give a ratio of 2:2:1.8.Blender was continued for another 30 seconds and the mixture was filtered through whatman No 1 filter paper on Buchner funnel with slight suction. The filtrate was transferred to a separator funnel and stand for few minutes. The chloroform layer lipid was evaporated using the rotary thin evaporator and the extracted lipid was stored in a deep freezer for further analysis.

Separation and identification of fatty acids:
Separation of fatty acids:

The liquid extracted from fresh and treated fish was sapontified with methanolic KOH (20%w/v) for 24 hr. at room temperature. The unsaponifiable matter was extracted three times with diethyl ether. The aqueous layer (soup) was acidified with HCL (1:1v/v) and the liberated fatty acids were washed several times with distilled water, then dried over anhydrous sodium sulphate.

Methylation of fatty acids: The fatty acids were converted to methyl esters as follows: the solvent was distilled off; the residue was dissolved in anhydrous dimethyl ether (0.5-1) and methylated by addition drop of diazomethane solution prepared as reported **by Vogel (1975)** until the yellow color persists. The mixture was then left at room temperature for 15 min. and the solvent wassubjected to gas – liquid chromatography (for identification of the methylated fatty acids).

Identification and determination of fatty acids methyl ester by gas – liquid chromatography (GLC):

GIC apparatus was shimaduze GCV-CM Unicom gas chromatography equipped with duel flame ionization detector. The fractionation of fatty acids methyl esters was conducted using silver column 10 % on gas chromatography Q11 80/100.The separation conditions were: the column temperature was programmed at 3 C/min.,initial temperature was 190C^{o} and final temperature was 270C^{o} and injection temperature was 270C^{o}. Flow rate of gases were: nitrogen 30ml/min.,hydrogen 1ml/min.,air0.50 ml/min. and sensitivity 16x10^2. The peak times of each peak with those of standard materials. Fatty acids were calculated as percentages of the total identified acids after measuring the peak areas by triangulation.

RESULTS AND DISCUSSIONS

A-Chemical composition, thiobarbituric acid (T.B.A.) and phenols contents:

Data presented in Table (1 and 2) showed the chemical composition, thiobarbituric acid (TBA,as mg malonaldehyde/kg sample) and phenols contents of rabbit both raw meats and smoked ones the results of the rabbit meat- used as raw material recorded 72.33%, 21.14%, 4.65%, 0.85% and 0.11mg malonaldehyde/kg sample for moisture, protein, fat, ash and TBA, respectively (on wet weight basis) while, phenols were not detected. The moisture content decreased from 72.33% before smoking to 65.14 and 64.84% after liquid and hot smoking. Decreasing per cent of moisture for liquid and hot-smoked rabbit meats were 9.94 and10.36%. This must be due to the smoking time of about 100 minutes for liquid than that of hot method (2hr.), in addition, the high moisture content of liquid-smoked samples may be due to the repeated spraying with liquid smoke containing water during smoking of rabbit. In general product moisture content is affected by processing condition. This indicates the importance of frozen storage -18C^{o} in reducing the moisture loss of smoked rabbit meats compared to cold storage, in addition, storage time was longer (90 days) than that of cold storage 4C^{o} (15 days).The protein content of the raw rabbit was 21.14 and 76.40% on wet and dry weight basis, respectively. By freezing protein was decrease from 76.40% of raw rabbit to reach 72.75 and 73.75% of liquid and hot smoked rabbit respectively. Meaning of that protein was more affected by hot than liquid smoked rabbit meats. However, protein contents of liquid and hot-smoked rabbit stored at-18C^{o} were higher than those stored at 4C^{o}.The fat content of the rabbit meats (raw) was 4.65 and 16.18% on wet and dry weight respectively. By smoking the fat content wasincreased on wet weight due to the decrease of moisture, nevertheless, it was decreased on dry weight as the fat contents decreased from 16.18% of raw rabbit to reach 15.52 and14.68% of liquid and hot-smoked rabbit meats, respectively. It is evident that the loss of fat was higher for the hot smoked rabbit than that of the liquid smoked rabbit and this may be due to the effect of smoking temperature, which was higher in hot (70C^{o}) and liquid (60C^{o}) smoking, consequently higher melting and dipping of some fat was occurred for hot than liquid smoking. On dry weight the fat contents of all the samples stored at 4C^{o} or -18C^{o} were decreased end of storage periods. However, fat content of liquid smoked rabbit meat and hot smoked rabbit meat stored(90 days) at-18C^{o} were higher than those stored (15 days) at 4C^{o}.Also, the percent decrease of fat for liquid and hot smoking and storage at 4C^{o} for 15 days was 20.49 and 23.16%,respectively,on dry weight in the end of storage. Corresponding 7.86 and 8.92% the same smoked samples stored at -18c for 90 days, the lowest loss of fat was recorded for liquid-smoked rabbit followed by hot smoking, respectively. Loss of fat with dripping or due to escape of some fat breakdown volatile compounds as malonaldehyde.

Thiobarbituric acid TBA, as mg malonaldehyde /kg sample was used as an important indicator for testing the oxidative rancidity of the samples this

study. From, the same table, it could be noticed that the raw rabbit meats used as raw material for producing smoked rabbit had TBA value of 0.11-0.40 mg malonaldehyde MA/kg sample, on ww and dw, this value of TBA was somewhat higher than that of fresh rabbit meats, may be due to that raw material was an imported smoked rabbit meat product. By smoking with liquid and hot smoking, immediately after smoking zero time, the liquid smoked rabbit meats had lower 0.44-1.26mg MA/kg samples then that of the hot smoked rabbit which had values of 0.51-1.45 mg MA/Kg sample (on WW and DW)respectively. The low TBA value of liquid smoked samples than that hot smoked samples one may be due to the direct contact between the liquid smoke compounds some of these compounds reacts as antioxidants. By storage at 4C^{o}, the TBA values of all the smoked samples were increased by the increasing of storage time. However, it could be observed that by the end of storage, the liquid smoked samples had lower TBA values 0.95 and 2.54 mg MA/Kg samples compared with hot smoked samples 1.54 and 3.92 mg MA/kg samples either on W.w or on D.w basis respectively. But, TBA values of all smoked rabbit stored at -18C^{o}were had lower compared with smoked rabbit stored at 4Cindicating more oxidation and partial breakdown of malonaldehydeTBA values of smoked rabbit stored at -18C^{o} were lower than those stored at 4C^{o}. Also, TBA values of all smoked rabbit by liquid and storage at -18C^{o} had lower compared with smoked rabbit meat by hot smoking and storage -18Cduring storage period.

Phenols were not detected in raw rabbit meats. By smoking with liquid and hot smoking, the liquid smoked rabbit had the higher phenols content than that of hot smoking, (20.56 and 58.98, 17.70 and 50.34 mg/100g samples on W.w and D.w respectively. Values by the end of storage at -18C^{o} (90 days) were (18.32 and 50.29) and 14.76 and 41.47 mg/ 100g for liquid and hot smoked rabbit meats respectively. Also, it could be noticed that the loss of phenols was lower for all smoked rabbit stored at -18C^{o} compared with that stored at 4C^{o}. In all this, the development of oxidative rancidity may have an important influence on the stability of processed products containing rabbit meat.

B-The functional properties of smoked rabbit meats and storage:

Are very important for the final characteristics of their finally processed products, therefore, water holding capacity WHC, total volatile nitrogen TVN, plasticity and roasting loss% were determined for rabbit meats raw and smoked rabbit meat with liquid and hot smoking used in this investigation and the obtained results are illustrated in table(3), Results in table (3) indicated that WHC,TVN, plasticity and roasting loss% were 2.41, 5.60 mg/100g sample, 3.85 and 15.78% respectively of rabbit meat(raw), while smoked rabbit meat with liquid and hot smoking were 2.75cm2, 7.50 mg/100g samples, 2.94cm2 and 18.65% and 2.87cm2, 9.80mg/100g sample, 2.75cm2 and 20.47% respectively. Smoked rabbit meats with liquid and hot smoke caused increase of TVN and roasting loss, but decrease of WHC and plasticity, the increase of TVN by smoking may be ascribed to smoking temperature that was 70C^{o} and salting step used before smoking, which enhances the autolysis of protein. The mentioned decrease in protein during smoking may be due to the loss of nitrogen. Concerning, the functional

properties of smoked rabbit meats with liquid and hot smoking during storage at $4C^{o}$ and – $18C^{o}$, the results indicated that, smoked rabbit meats with liquid had the higher in quality compared with hot smoked samples either storage at $4C^{o}$ or $-18C^{o}$.

C-Weight changes during smoking process.

The results of weight changes(gm) of the whole rabbit meat during processing and smoking with liquid and hot smoking including salting in brine at $4C^{o}$ for 8-12 hr. ,desalting and smoking by liquid smoke spray method at smoking temperature of $70C^{o}$ for 100 min. and smoking by hot at smoking temperature at $90C^{o}$ for 2.5hr. are presented in table (4).From, the results of table (4), it could be noticed that the weight losses due to only salting (dressing) was about 40% (calculated on raw weight basis) for whole live rabbit meats but, the total loss% due to salting and smoking with liquid smoke and hot smoke were about (9.86 and 8.70) and (9.57 and 9.65%) respectively compared with raw rabbit meats. While, the total loss% due to alloy processing (salting + desalting+ smoking) = 13.19 and 14.53, respectively compared with raw rabbit meats. This, means that the liquid-smoked whole rabbit recorded lower total loss of weight than that of smoked whole rabbit by hot smoking, which may be due to the higher moisture content of smoked rabbit meat with liquid smoke(spray method),also, due to different of smoking temperature and time of smoking.

D-Fatty acids composition and fractions:

Fatty acids composition(as% of total fatty acids) and fractions (%) or raw rabbit meat as affected by liquid and hot –smoking methods and storage conditions (including storage at ($4C^{o}$ and $-18C^{o}$) are presented in Tables(5,6 and 7) From the results, concerning the raw rabbit, it could be noticed that the predominant saturated fatty acids was the linoleic (C18:2,which was 19.78%) followed by the palmitoleic (C16:1, 19.73%) and oleic C18:1 which was 16.79% of the total fatty acids, respectively. Moreover, concerning the rabbit meats also, it could be observed Table(5) that the total polyunsaturated fatty acids (including di- and tri- unsaturated fatty acids) was(23.57%) of total fatty acids. By adding the percent of the total mono-unsaturated fatty acids 41.13%, the total un-saturated fatty acids will be recorded as 64.70%. At the same time, the total saturated fatty acids were recorded 35.30%.Accordingly,the Ks- which was obtained by dividing the total unsaturated fatty acids/the total saturated fatty acids-of the raw rabbit meats was high (1.83) indicating the high per cent of the total unsaturated fatty acids versus the low per cent of saturated fatty acids. From the same Tables(5,6 and 7) by smoking with liquid and hot (immediately after smoking, zero time), it is evident that the smoking process affected the fatty acids composition as some fatty acids were decreased and others were increased. On the other hand, with respect to the essential fatty acids (linoleic and linolenic,), the per cent of total essential fatty acids (immediately after smoking) were 20.32% and 16.31% % for rabbit smoked by liquid and hot smoking, respectively. Corresponding % for raw rabbit. This indicated that all smoking methods affected the essential fatty acids content, nevertheless, according to the per cent of total essential fatty acids in the smoked samples, the liquid- smoked

rabbit was the best followed by hot smoked rabbit. Also, the results in Table(7) showed the fatty acids fractions(%) of raw rabbit as affected by smoking liquid and hot methods, as at zero time, the total saturated fatty acids(TSFAs) were increased while the total unsaturated fatty acids(TUFAs) were decreased overall the smoking methods provided that the level of oxidation(decreasing level of the total unsaturated fatty acids) for the liquid-smoked rabbit was lower than those of hot smoking whereas, the TUFAs were 62.51 and 59.33 % for liquid and hot smoked rabbit, respectively. Corresponding 64.70 % for raw rabbit. Moreover, the (Ks, TUFAs/TSFAs) and Du were supported these results. The high the Ks value and Du were (1.83, 1.67 and 1.46) and (92.06- 90.74 and 79.24) for raw rabbit, liquid and hot-smoked rabbit respectively. By storage either at $4C^{o}$ or at-$18C^{o}$ on the whole (Tables 5, 6 and 7) some saturated fatty acids were increased and others at the same time decreased and vice-versa. Concerning the unsaturated Fatty acids during storage, almost un- FAs decreased due to oxidation provided that the decreased rate (oxidation rate) was less when the storage temperature was decreased from $4C^{o}$ to -$18C^{o}$. Moreover, according to the smoking method and storage temperature, during storage either at 4 or at -$18C^{o}$ the liquid smoked rabbit showed lower oxidation than hot smoked rabbit one. However, it could be observed that the increasing rate of TSFAs was lower at-$18C^{o}$ than that at $4C^{o}$.It is evident that during storage the liquid-smoked rabbit fat was more stable than that of hot smoked one as indicated by more lipid oxidation. This indicates that smoked rabbit may be stored with high quality at -$18C^{o}$ for 60 days.

Taple(1):Chemical composition,Thiobarbituric acid(TBA) and phenols contents of rabbit meat as affected by smoking with liquid smoking and storage conditions.

Components	Raw (rabbit meat)		Zero time**		Storage temperature© and period in days											
					Cold storage(4C)						Freezing at -18C					
					5		10		15		30		60		90	
			WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW
	WW	DW	Liquid smoked whole rabbit meat													
1	72.33	-	65.14	-	64.14	-	63.79	-	62.56	-	65.16	-	64.18	-	63.57	-
2	21.14	76.40	25.36	72.75	26.36	73.81	26.36	72.80	26.36	70.41	25.11	72.07	24.34	67.95	24.21	66.46
3	4.65	16.18	5.41	15.52	5.54	15.45	5.11	14.11	4.62	12.34	5.36	15.38	5.41	15.10	5.21	14.30
4	0.85	3.07	2.34	6.71	2.67	7.45	3.97	10.96	4.58	12.23	2.66	7.63	3.21	8.96	3.64	10.00
5	0.11	0.40	0.44	1.26	0.67	1.87	0.75	2.07	0.95	2.54	0.55	1.58	0.68	1.90	0.78	2.14
6	-	-	20.56	58.98	19.86	55.38	20.34	56.17	19..32	51.60	19.45	55.83	19.25	53.74	18.32	50.29

1-Moisture% 5-Thiobarbituric(TBA,mg malonaldehyde/Kg)

2-Protein% 6- Phenols(mg/100g)

3-Fat% **Immediately after smoking

4-Ash% WW-on wet weight basis

DW-on dry weight basis

Taple(2): Chemical composition,Thiobarbituric acid(TBA) and phenols contents of rabbit meat as affected by smoking with hot smoking and storage conditions.

Components	Raw (rabbit meat)		Zero time**		Storage temperature© and period in days											
					Cold storage(4C)						Freezing at -18C					
					5		10		15		30		60		90	
			WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW	WW	DW
	WW	DW	Hot smoked whole rabbit meat													
1	72.33	-	64.84	-	64.72	-	62.56	-	60.74	-	65.91	-	65.29	-	64.41	-
2	21.14	76.40	25.93	73.75	24.39	69.13	25.41	67.87	24.96	63.58	24.81	72.78	24.63	70.96	24.91	69.99
3	4.65	16.18	5.16	14.68	5.42	15.36	4.66	12.45	4.43	11.28	5.94	17.42	4.63	13.34	4.76	13.37
4	0.85	3.07	3.33	9.47	4.81	13.63	6.69	17.87	6.72	17.12	3.33	9.77	4.19	12.07	4.61	12.95
5	0.11	0.40	0.51	1.45	1.34	3.80	1.27	3.39	1.54	3.92	1.21	3.55	1.10	3.17	1.56	4.38
6	-	-	17.70	50.34	18.34	51.98	18.54	49.52	17.63	44.91	17.75	52.07	16.74	48.23	14.76	41.47

1-Moisture% 5-Thiobarbituric(TBA,mg malonaldehyde/Kg)

2-Protein% 6- Phenols(mg/100g)

3-Fat% **Immediately after smoking

4-Ash% WW-on wet weight basis

DW-on dry weight basis

Table (3): Physical properties of rabbit meats and as affected by smoking methods and storage conditions.

Properties	Rabbit meats (raw)	Zero time*	Storage temperature© and period(in day)					
			Cold storage(4C)			Frozen storage-18C		
			5	10	15	30	60	90
	Liquid smoked rabbit meats							
WHC	2.41	2.75	2.87	3.40	3.95	2.87	3.11	3.50
T.V.N(mg/100g)	5.60	7.50	10.5	12.50	14.70	9.80	10.5	12.50
Plasticity(cm2)	3.85	2.94	2.54	2.11	1.78	2.94	2.75	2.54
Roasting loss	15.78	18.65	17.85	19.31	25.14	18.54	20.54	20.78
	Hot smoked rabbit meats							
WHC	2.41	2.87	3.21	3.41	4.45	2.95	3.11	3.45
TVN	5.60	9.80	12.50	17.50	21.00	10.50	12.50	14.00
Plasticity(cm2)	3.85	2.75	2.64	2.23	1.41	2.71	2.40	2.20
Roasting loss	15.78	20.47	23.15	22.19	25.78	19.88	20.45	25.47

*Immediately after processing

WHC=Water holding capacity (cm2/0.3g sample).

TVN=Total volatile nitrogen (mg/100g samples).

Table (4): Changes in weight (gm) of rabbit (raw) during processing of smoking

Processing / Methods	Live weight	Dressing (raw rabbit meats)	Immediately after salting	After desalting	Immediately after smoking	Weight (g)	Finally total loss (%)
Liquid smoking	1995.45	1210.11	1090.85	1150.57	1050.52	159.59	13.19
Hot smoking	1985.84	1195.11	1080.79	1130.68	1021.54	173.57	14.52

Table (5): Fatty acids composition of rabbit meat as affected by liquid smoking and storage conditions.

Fatty acids	Raw(rabbit meats)	Zero time	Storage temperature© and period in day					
			Cold storage(4C°)			Frozen storage -18C°		
			5	10	15	30	60	90
C12:0	-	-	0.31	-	-	-	-	-
C14:0	2.19	5.61	3.14	0.54	-	5.64	-	5.91
C15:0	1.51	3.66	2.61	4.31	3.41	0.9	3.41	0.41
C16:0	10.61	10.20	10.91	16.61	14.31	11.81	13.60	14.71
C16:1	19.73	19.14	18.31	15.34	17.41	16.71	20.71	19.61
C17:0	0.31	2.00	-	-	-	0.60	-	-
C18:0	13.41	10.61	10.61	14.75	18.41	12.71	8.20	10.71
C18:1	16.79	20.41	14.71	18.31	16.61	18.61	17.80	13.21
C18:2	19.78	12.41	18.71	17.21	13.61	18.71	16.59	17.71
C18:3	3.79	7.91	6.60	3.11	4.41	4.71	3.22	1.91
C20:0	6.31	5.41	10.40	7.71	3.41	5.60	12.00	4.91
C20:1	4.61	2.64	2.00	2.11	2.61	2.40	0.78	1.79
C22:0	0.50	-	1.69	-	5.43	1.60	3.69	5.71
C24:0	0.46	-	-	-	0.38	-	-	3.41

Table (6): Fatty acids composition of rabbit meat as affected by hot smoking and storage conditions.

Fatty acids	Raw(rabbit meats)	Zero time	Storage temperature© and period in day					
			Cold storage(4C°)			Frozen storage -18C°		
			5	10	15	30	60	90
C12:0	-	0.31	-	-	2.19	-	1.90	-
C14:0	2.19	5.75	5.71	3.61	6.71	3.61	7.32	10.55
C15:0	1.51	2.61	2.91	4.61	2.13	2.69	6.31	7.22
C16:0	10.61	11.91	14.61	12.41	15.72	12.71	15.41	10.41
C16:1	19.73	20.31	18.81	17.71	15.80	22.61	16.71	14.72
C17:0	0.31	-	1.91	0.61	2.79	-	3.21	4.55
C18:0	13.41	10.61	12.71	10.71	15.41	12.71	10.71	8.65
C18:1	16.79	20.71	15.71	20.71	10.71	14.61	13.91	20.32
C18:2	19.78	12.71	8.61	10.61	7.32	12.71	10.97	7.66
C18:3	3.79	3.60	8.41	4.41	6.71	2.19	6.34	2.14
C20:0	6.31	10.40	10.61	14.61	10.79	16.16	7.21	10.45
C20:1	4.61	2.00	-	-	-	-	-	-
C22:0	0.50	1.69	-	-	3.72	-	-	3.33
C24:0	0.46	-	-	-	-	-	-	-

Table (7): Fatty acids fractions (%) of rabbit meats (raw) as affected by smoking methods and storage conditions.

Fatty acids fractions	Raw(rabbit meat)	Zero time**	Storage temperature© and period in days					
			Cold storage(4C)			Frozen storage -18C		
			5	10	15	30	60	90
		Liquid smoked rabbit meats						
T. sat.	35.30	37.49	39.67	43.92	45.35	38.86	41.90	45.77
T.un sat.	64.70	62.51	60.33	56.08	54.65	61.14	58.10	54.23
T.momo.	41.13	42.19	35.02	35.76	36.63	37.72	39.29	40.11
T.di.	19.78	12.41	18.71	17.21	13.61	18.71	16.59	13.21
T.tri.	3.79	7.91	6.60	3.11	4.41	4.71	3.22	1.91
T.poly.	23.57	20.32	25.31	20.32	18.02	23.42	19.81	15.12
Ks.	1.83	1.67	1.52	1.28	1.21	1.57	1.39	1.18
Du.	92.06	90.74	92.24	79.51	77.08	89.27	82.13	72.26
Hot smoked rabbit meats								
T.sat.	35.30	40.67	48.46	46.55	59.46	47.88	52.07	55.16
T.unsat.	64.70	59.33	51.54	53.45	40.59	52.12	47.93	44.84
T.mono.	41.13	43.02	34.52	38.42	26.51	37.22	30.62	35.04
T.di.	19.78	12.71	8.61	10.61	7.32	12.71	10.97	7.66
T.tri.	3.79	3.60	8.41	4.41	6.71	2.19	6.34	2.14
Tpoly.	23.57	16.31	17.02	15.02	14.03	14.90	17.31	9.80
Ks	1.83	1.46	1.06	1.15	0.68	1.09	0.92	0.81
Du	92.06	79.24	76.97	72.87	61.28	69.21	71.58	56.78

T. sat. = Total saturated fatty acids **=immediately after smoking
T.unsat. =Total unsaturated fatty acids
T.mono. = Total mono-unsaturated fatty aids
T.di. = Total di-unsaturated fatty acids
T. tri. = Total tri- unsaturated fatty acids
T.poly. =Total polyunsaturated fatty acids
Ks=T. UN sat. /T.Sat.
Du. =1(mono-unsaturated fatty acids) + 2(di-unsaturated fatty acids) + 3(tri-unsaturated fatty acids).

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تدخين لحوم الارانب بطريقة حفظ صحية

على احمد عبد الحليم
قسم بحوث تكنولوجيا اللحوم و الاسماك –معهد بحوث تكنولو جيا الاغذية – مركز البحوث الزراعية – جيزة مصر

تتميز الارانب بمحتواها العالى من البروتين عالى القيمة الغذائية و نقص محتواها من الدهون الحيوانية المشبعة وارتفاع نسبة الاحماض الدهنية الغير مشبعة و نقص محتواها من الكولسترول و لذلك تتميز دهون الارانب بقابليتها العالية للتزنخ و الاكسده, تم تدخين لحوم الارانب الكاملة بسائل التدخين وتدخين على الساخن و تم تخزين الارانب المدخنة على درجة حرارة ٤ درجة مئوى لمدة ١٥ يوم و على درجة -١٨ درجة مئوى لمدة ٩٠ يوم تم تقدير التركيب الكيميائى و الخواص الفيزيو كيميائية و الاحماض الدهنية فى لحوم الارانب الطازجة و بعد التدخين مباشرة و خلال فترات التخزين . اتضح من النتائج ان الخصائص الوظيفية كانت اعلى فى لحوم الارانب المدخنة لسائل التدخين عن المدخنة على الساخن و ذلك بعد التدخين مباشرة ،بينما كانت الخصائص الوظيفية اعلى فى لحوم الارانب المدخنة و المخزنة على درجة -١٨ درجة مئوية بالمقارنة بالمخزنة على درجة ٤ درجة مئوية و كذلك ادت عمليات التدخين و التخزين على درجة حرارة -١٨ درجة مئوية الي المحافظة على الاحماض الدهنة الغير مشبعة و يمكن ان نستنتج من هذا ان تدخين لحوم الارانب بسوائل التدخين امر مهم لانتاج منتجات جديدة عالية الجودة ذات قابلية عالية للحفظ لفترات طويلة.

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