Investigation of microstructure of cooked sausages containing pork or beef fatty tissues

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Investigations of physico-chemical properties and histological structure of fatty tissues speak in the favour of the conception that not only chemical lipids but also the whole fatty tissue structure may be a factor which determines its "firmness" or "softness". The technological value of a fatty tissue increased simultaneously with the content of "nonfat" components.

Frankfurters prepared with back fat showed the lowest thermal loss. Frankfurters manufactured from chilled fresh beef were superior in quality in relation to those prepared with frozen beef. The highest scores for organoleptic properties were attributed to frankfurters containing jowl fat and the lowest one - to frankfurters containing kidney fat.

Although identical in general, the basic microstructure of frankfurters prepared with beef fatty tissues shows certain differences, particularly in periphery layers. The participation of fatty tissue elements in periphery layers of frankfurters containing beef fatty tissues is higher than in those of frankfurters prepared with pork fatty tissues.

Untersuchung der Mikrostruktur der gekochten Würsten mit der Zugabe des Schweine- und Rinderfettgewebes

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Die Untersuchung der physikalisch-chemischen Eigenschaften und der histologischen Struktur von Fettgeweben deuten auf die Tatsache dass nicht nur das Fett allein sondern auch das Fettgewebe selbst jene Faktoren sein können die seine "Festigkeit" oder "Weichheit" voraussetzen. Der technologische Wert des Fettgewebes steigt parallel mit dem "unfetten" Bestandteilengehalt.

Der mit dem Rückenfettgewebe hergestellte Frankfurter weist den kleinsten thermischen Gewichtverlust auf. Jedoch der Frankfurter der aus dem frischen, gekühlten Fleisch hergestellt war wies die bessere Qualität auf als der der aus gefrorenem Rindfleisch erzeugt wurde. Die besten organoleptischen Eigenschaften wies der Frankfurter auf der den Backenfett in sich hatte und die schlechtesten derjenige dem das Nierenfettgewebe des Rindes zugesetzt wurde.

Obwohl identisch, die Mikrostruktur von Frankfurter der mit dem Rinderfetgewebe zubereitet war weist bestimmte Unterschiede auf, besonders in den peripheren Schichten, von demjenigen der mit dem Schweinefettgewebe hergestellt wurde. Der Gehalt von Fettgewebeelementen in den peripheren Schichten des aus dem Rinderfettgewebe zubereiteten Frankfurter ist grösser als in dem jenes Frankfurters der mit dem Schweinefettgewebe hergestellt wurde.

6.11

Examination de la microstructure des saucisses cuites fabriquées avec des tissues adipeaux de porc ou de boeuf

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L'examination des caractéristiques physico-chimiques et de la structure hystologique témoignent que non seulement les lipides purs mais aussi la structure même des tissues adipeux peut être le facteur déterminant sa dureté ou sa tendreté. La valeur technologique d'un tissue adipeux augmente simultanément avec son contenue de composants non-grasseux.

Les saucisses cuites fabriquées par l'addition du gras subcutané dorsal montrent les pertes de cuisson qui sont les plus basses. Les saucisses preparées avec de la viande refrigérée sont d'une qualité supérieure á celles preparées avec de la viande de boeuf congelée. La valeur organoleptique la plus élevée a été attribuée aux saucisses contenant le gras de gorge et la moins élevée aux saucisses avec le gras de boeuf perirenal.

Bien qu'identique en principe, la microstructure de base de saucisses fabriquées avec des tissues adipeux de boeuf, montre certaines différences, particulièrement dans ses couches de péripherie. La participation des éléments de tissue adipeux dans les couches de péripherie des saucisses fabriquées avec du gras de boeuf est plus élevée que dans les saucisses préparées avec des tissues adipeux de porc.

Исследование микроструктуры сосисок с добавкой жировой ткани свиней и крупного рогатого скота

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Исследования физикохимических свойств жира и гистологической структуры жировых тканей указывают на тот факт что не только химически чистой жир но и самая жировая ткань могут стать факторами обусловляющими их "плотность" или же "мягкость". Технологическая ценность жировых тканей возрастает параллельно с содержанием "нежирных" составных частей.

Франкфуртские сосиски которые сделаны с хребетовой шпиной имеют самые меньшие потери. Франкфуртские сосиски произведенные из свежего охлажденного мяса говядины обнаружили лучше качество чем сосиски из замороженной говядины. Самые качественные органолептические свойства имели сосиски содержавшие щековину , а самые хужие имелись у сосисок с добавкой около почечного жира крупного рогатого скота.

Несмотря на это что они в своей основе идентичны , микроструктура сосисок сделанных с жировой тканью крупного рогатого скота является в определенном смысле различной от сосисок сделанных с жировой тканью свней, особенно в периферийных слоях. Участие элементов жировой ткани в периферийных слоях сосисок сделанных с жировой тканью крупного рогатого скота больше чем у сосисок содержавших только жировую ткань свиней.

Investigation of microstructure of cooked sausages containing pork or beef fatty tissues

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Introduction

Various explanations regarding the factors and character of physical systems responsible for the structure of cooked sausage can be found in the literature (Hansen, 1960; Swift and Sulzbacher, 1963; Helmer and Saffle, 1963; Meyer et al., 1964; Carpenter et al.,1966; Trautman, 1966; Saffle et al.,1967; Schut, 1969; Ivey et al.,1970; Ackerman et al.,1971; Grau,1972; Acton and Saffle, 1972; Smith et al.,1973; Haq et al., 1973). According to Wilson (1960) and Townsend et al.,(1968), the batter of these sausages is very similar to real emulsion of oil in water whereas Savić et al.,(1965), reported that emulsions of fatty tissues,unlike emulsions of chemical fats, do not represent simple but complex dispersion systems, the integral parts of which are also suspensions and, to somewhat smaller extent, colloidal or semicolloidal solutions as well. Tadić (1965) also emhasized that systems obtained by homogenization of fatty tissues and water are manifold structural systems.

Taking into consideration that many literature data concerning the formation and stability of fat emulsion are incomplete and contradictory, the following tasks were set in this study; 1) study of differences in the structure of major pork and beef fatty tissues and differences in physico-chemical properties of their fats and 2) the influence of pork and beef fatty tissues on the production losses,some quality characteristics and microstructure of frankfurters.

Material and Methods

FATTY TISSUES: pork - jowl fat, back fat and leaf fat; beef - brisket fat and kidney fat. BEEF: 2 years old cattle. EMULSIFIERS: Sodium caseinate EM-6 (De Meijerij, Veghel, Holland) Supro 500 (Ralston Purina,USA), Gervita S (Gervais - Danone AG,München) and Tari Normal (Gebr. Giulini,West Germany). MEAT BATTER: beef trimmings (74%), ice (22%), NaCl(2%),$NaNO_2$(0,012%), Tari Normal (0,5%) and spices. FRANKFURTERS(meat batter 78,6% and pork or beef fatty tissues 21,4%) were smoked(90 min.), cooked (20 min.) and chilled (15 min.) in an "Atmos" unit.

The COMPOSITION of fatty acids was determined by the Varian Aerograph gas chromatograph,model 661-1. Sections of fatty tissues (20 microns) as well as sections of frankfurters, prepared in the Pears cryostat (Brights's Huntingdon, London), were stained with: Sudan III solution, Oil Red solution or Sudan Black B solution. Determination of the THERMOSTABILITY of meat batter and raw sausage mass were done at 70°C and 120°C, respectively.

Results and discusion

a) Properties and structure of pork and beef fatty tissues

Investigation of chemical composition, physico-chemical properties (Table 1) and histological structure (Fig.1) of fatty tissues bespeak the conception that not only chemical fat, but also the whole fatty tissue structure may be a factor which determines its "firmness"(Fig.1 a, b,d) or "softness" (Fig. 1 c,e). Subcutaneous of "firm" fatty tissues (particulary jowl fat and brisket fat), comprising irregular lobules of courser fat cells, contain also considerable quantities of muscular and connective tissue elements as well as vascular, glandular and other components. The quantity of their "nonfat" material varies dependent on the type of fatty tissue. The maximum quantity is found in periphery layers of jowl and the minimum one in caudoventral parts of back fat.

From the above mentioned, it commes out that functional properties of fatty tissue are improved simultaneously with the increase of the content of "nonfat" components. Such fatty tissue includes somewhat lower percentage of fat (Table 1), but keeps its integrity more completely after grinding and heat processing. From the aspect of cooked sausage production, jowl is,consequently, a better sausage raw material than back fat.

Table 1. Chemical composition of fatty tissues and physico-chemical properties of fats extracted thereof

Elements		Fatty tissues				
		Jowl	Back	Leaf	Brisket	Kidney
Composition (%)	water	9.33	5.71	5.05	30.41	5.68
	protein	2.61	1.52	2.80	5.70	2.05
	fat	88.45	93.08	92.52	64.05	92.40
	ash	0.07	0.08	0.05	0.21	0.06
Properties of fats	melting point (°C)	30.50	37.30	45.20	33.70	47.50
	solidification point (°C)	22.00	22.50	30.00	23.00	37.90
	iodine number (Hanuš metod)	49.28	47.54	50.24	38.20	29.88
Total fatty acids (%)	saturated acids	32.09	32.08	46.69	35.58	52.97
	unsaturated acids	66.86	66.37	52.09	59.09	44.50
	ratio saturated/unsaturated	0.48	0.48	0.89	0.60	1.19
Fatty acids (% of total fatty acids)	capric (C10:0)	trace	trace	trace	trace	trace
	lauric (C12:0)	trace	trace	trace	trace	trace
	myristic (C14:0)	1.27	1.07	1.33	3.18	2.16
	nonidentified	0.00	0.00	0.00	2.16	0.73
	palmitic (C16:0)	20.71	20.01	24.01	23.18	19.97
	palmitoleic (C16:1)	3.61	4.18	3.21	8.87	2.53
	nonidentified	1.05	1.55	1.22	2.59	1.80
	stearic (C18:0)	10.11	11.00	21.35	9.22	33.37
	oleic (C18:1)	47.21	46.80	32.90	47.17	37.74
	linoleic (C18:2)	13.71	13.60	14.10	2.70	1.70
	linolenic (C18:3)	2.33	1.79	1.88	0.93	0.00

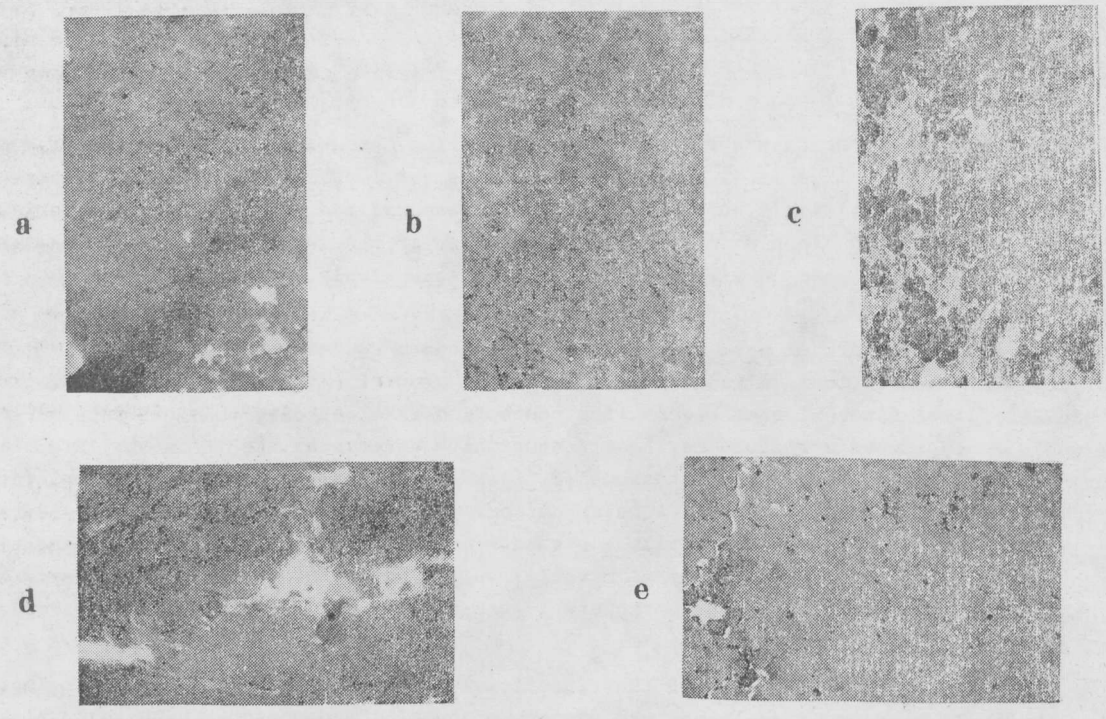


Figure 1. Typical microphotographs of histological sections of pork (a = jowl fat, b = back fat, c = leaf fat) and beef fatty tissues (d = brisket fat, e = kidney fat) stained with Sudan III solution (magnification 20 X)

b) Examination of the microstructure of cooked sausage systems

1. Thermal loss and reheating loss.- Frankfurters prepared with leaf or back fat show the lowest thermal and reheating losses. These losses are somewhat higher in frankfurters prepared with kidney fat or jowl fat and the highest in frankfurters with brisket fat. These results also suggest that the use of interior fatty tissues in both pork and beef sausages reduces the losses (Table 2) of frankfurters with casing.

Table 2. Thermal loss and reheating loss of frankfurters prepared with fatty tissues from different anatomical regions of pork and beef carcasses

Frankfurters prepared with	Thermal loss (%) of frankfurters prepared from		Reheating loss (%) of frankfurters prepared from			
	chilled fresh beef	frozen beef with 2% Gervita S	chilled fresh beef		frozen beef with 2% Gervita S	
			with casing	without casing	with casing	without casing
Jowl fat	9.95	-	1.11	-	-	-
Back fat	9.27	-	0.90	-	-	-
Jowl + Back fats (1:1)	9.29	9.80	0.88	1.58	1.34	1.03
Leaf fat	9.10	10.10	0.87	1.19	3.72	5.18
Brisket fat	11.90	11.50	1.18	0.60	1.99	2.72
Kidney fat	9.68	10.85	1.16	0.72	3.05	4.63

2. Sensory evaluation of experimental frankfurters.- It is worthy to emphasize that frankfurters manufactured from chilled fresh meat were superior in quality than those prepared with frozen beef with the addition of 2% of Gervita S. The highest number of scores was attributed to frankfurters containing jowl and the lowest one to frankfurters containing kidney fat. In relation to products prepared with subcutaneous fatty tissue, frankfurters prepared with interior fatty tissue showed reduced fat separation, more intensive shineness and smoothness of the surface, and finer homogenity of the cut surface.

3. Histological examination of experimental frankfurters.- Microphotographs of histological sections of frankfurters, prepared with fatty tissues from various anatomical regions of pork or beef carcasses (Figure 2), indicate that the frankfurter structure is basically formed from a homogenous ground mass - matrix, composed of fine mutually interweaved muscular and connective tissue elements, which enclose irregular and numerous islands of larger tissue conglomerates of fragments. The matrix of central layers of frankfurters does not give the impression of compactness. Its structure is more tender and it contains more fragments of fatty tissue as well as released fat being here and there emulsified. However, the matrix of periphery layers of frankfurters has a rough, almost granular structure and it is a dense and compact mass, containing more intensively thermo-modified elements of different tissues.

Although identical in common, the basic microstructure of frankfurters prepared with beef fatty tissues shows certain differences, particularly in periphery layers. Namely, the participation of fatty tissue elements in periphery layers is proportionally higher than in frankfurters prepared with pork fatty tissues. Consequently, differences between periphery and central layers in beef fat frankfurters are considerably lower.

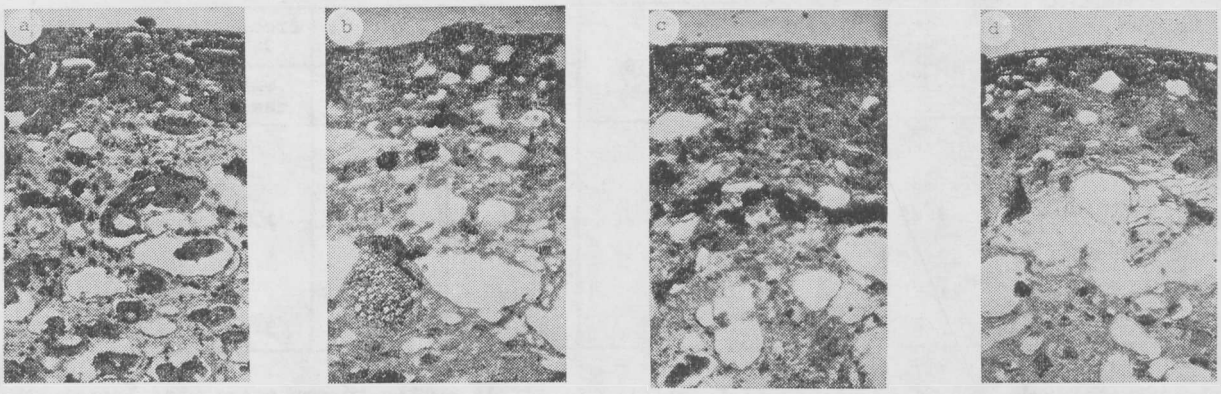
Conclusion

1. From the aspect of cooked sausage production, pork and beef fatty tissues should be divided according to their structural composition and not according to the physico-chemical nature of fat contained in them. Traditional division into "firm" and "soft" fatty tissues is justifiable in both pork and beef carcasses.

2. The basic structure of frankfurters is a finely ground, netlike protein sol "matrix", compo-

sed of numerous, finely ground and mutually interweaved elements of muscular, connective and fatty tissues as well as vascular and other microstructural elements. By heat processing during smoking, first of all during cooking, the matrix gets the characteristics of gel which includes irregularly distributed and not uniformly ground fragments of different tissues, globules of free fat and juice, and other additional elements. The basic matrix of periphery layers is characterized by higher coagulation rate of proteins and, consequently, by more compact and concentrated gel containing higher content of smoke components and infiltrated fat. Even when the best technique of stuff preparation is applied, this fat flows to the sausage surface protecting it from superfluous effect of heat and smoke components.

3. Suspensions appear also in complex forms of secondary and even tertiary emulsions in which the primary emulsions or/and the whole systems are resuspended. Since the basic matrix contains considerable amounts of dissolved salts and cellular juice, there are also isolated islands of



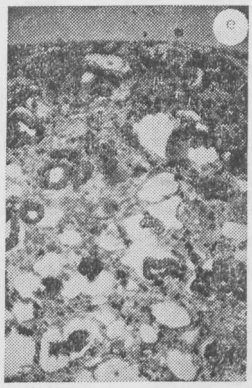


Figure 2. Microphotographs of superficial and central layers of frankfurters prepared with different fatty tissues (a = jowl fat, b = back fat, c = leaf fat, d = brisket fat, e = kidney fat) and stained with Sudan III solution (magnification 20 X)

real and colloidal solutions, one portion of them only being liable to slight changes during heat processing. A part of melted fat can also form emulsions, but in frankfurters they are of secondary importance ant their presence increases with the use of interior fatty tissues.

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