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## **PARTIAL SUBSTITUTION OF ANIMAL FAT WITH PLANT ORIGIN OIL IN THE PRODUCTION OF FINELY COMMUNUTED SAUSAGES**

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### **ABSTRACT**

Application of vegetable fat in experimental production of comminuted, scalded sausages was studied in this paper. An essential part (20,35 or 50%) of animal fat was substituted with food grade rape oil, and the influence of such substitution on the quality of final products was determined. Results of sensoric examination showed no significant differences between control (without oil) and oil contained sausages with substitution level equal to 35%.

**Key words:** finely comminuted, scalded sausages, rape oil, vegetable fat, consumer quality

## INTRODUCTION

The reduction of animal fat consumption with respect to calorificity and cholesterol content is nowadays one of the most important nutritional requirements postulated by specialists of food science and technology. Apart from carbohydrates, fats are the main source of energy in the human diet, also delivering vitamins (A, D, E and K) and unsaturated fatty acids, commonly occurring in fats of plant origin. Not only the amount but also the type and mutual ratio of consumed fats in respect to their origin are important from the point of view of human health [2]. Due to a commonly held opinion, the ratio of polyunsaturated and saturated fatty acids (which are mostly present in animal fats) should be 20:5 or 22:6 which means the essential predominance of unsaturated fatty acids in the daily human diet [5].

Fats of animal origin are characterised by a relatively high content of cholesterol and small amount of polyunsaturated fatty acids, and therefore they are considered as one of potential causes of different diseases (so called: "diseases of civilisation"). The high consumption of meat and meat products increases the risk of falling ill with circulatory system diseases (in particular: sclerosis) [4]. On the other hand, it is difficult to change the nutritional habits of the society resulting from long term tradition or to stimulate higher consumption of plant origin fats and, at the same time, to reduce or eliminate animal fats from the human diet. Accordingly thus, the substitution of animal fat with plant origin oil in the production of some meat products seems to be an interesting technological alternative. Because of the specific taste and considerable level of comminution, these types of products are accepted today by a relatively wide group of consumers, and in particular, by children and older people. The commercial production of meat products with reduced content of animal fat, still demonstrating their typical taste and other quality factors, could be considered as an important contribution to the preventive cholesterol programme in Poland.

The principal aim of the work presented here was to produce an experimental, comminuted, scalded sausage with the use of plant origin fat (rape oil) and to investigate the main consequences of this technological operation for the quality of the final product.

## MATERIALS AND METHODS

Finely comminuted sausages ("Parówka" type) were prepared in the pilot meat plant of Institute of Meat Technology at the University of Agriculture in Poznań ([Table 1](#)).

**Table 1. Composition of experimental sausages (%)**

Ingredient	Code of product			
	A	B	C	D
Pork grade II	50	50	50	50
Pork grade III	30	30	30	30
Animal fat	20	16	13	10
Vegetable fat	-	4	7	10
Total :	100	100	100	100
Ice flake	25	25	25	25
Curing salts	2.0	2.0	2.0	2.0
Spices	0.1	0.1	0.1	0.1

To obtain the kind of meat slurry ("meat emulsion") the 24 h - cured pork meat of II. and III. grade and fat (all added in chilled form) were ground together with ice flakes using a typical cutter machine.

In order to determine cooking losses, instead of casings which are normally used for this type of meat products, metal cans of volume equal to 200 g were used. Next, the thermal treatment of meat emulsions was performed in open tanks until the temperature in the centre of each can was equal to 68°C.

Since results of some initial experiments (not presented here) indicated that a replacement of animal fat with an oil of plant origin to the maximal level of 50% had no negative effect on the quality of final products, four technological variants of experimental sausages were finally manufactured. While the control sausage, coded A, was manufactured without addition of plant origin oil, in the sausages coded B, C, D, animal fat was substituted by vegetable oil on levels 20, 35 and 50%, respectively. For the main experiment "cold" pressed rape oil (with peroxide value equal to 0.7 cm<sup>3</sup> Na<sub>2</sub>S<sub>2</sub> O<sub>3</sub>/1 g of fat and acid value equal to 0.3 mg of 0.1 n KOH per 1 g of fat, with low content of erucic acid) was selected. The quality of experimental sausages was evaluated both after 24h as well as after 120h of storage of final products in chilled conditions (4°C), using the following tests:

1. sensoric evaluation : performed by multipersonal panel of experts, according to 5-point rating, including : cross-section colour, taste, flavour and consistency of product [1];
2. cooking losses : determined after 24 h chilled storage as the difference between the total weight of canned meat product and the weight of sausage block only;
3. determination of peroxide and acid values for fat fraction isolated from experimental sausages, according to reference methods recommended by Polish Standards (Polish Standard PN-84/A-85803); additionally, the same parameters were also determined for fat isolated from meat emulsions directly after preparing the sausages.

## RESULTS

### 1. The Results of cooking losses determination

The heat treatment of experimental sausages resulted in forming transparent and homogenous jelly. The lack of fat clots indicated full emulsification of fat. It was found that the highest cooking loss (approx. 17.7%) was observed after 24 h of storage for sausages from group A (control, without plant oil), while the smallest cooking loss (9.8%) was found for sausages with 50% substitution of animal fat by rape oil (group D). The cooking losses for sausages from groups B and C were 14.1% and 12.8%, respectively. The correlation between the level of fat substitution and cooking losses was observed. Generally, with the increase of the rape oil amount in the sausage formulas, the reduction of cooking losses was observed. The absolute difference between the highest and the smallest value of this parameter for all of the examined samples was equal to 7.9%.

**Table 2. Cooking loss of examined sausages (%)**

Product	Cooking loss (%)
A	17.7
B	14.1
C	12.8
D	9.8

## 2. Determination of peroxide (LN) and acid values (LK)

It is well known, that long term storage lead to the undesirable changes of fat quality, called rancidity, caused by the influence of many factors like: oxygen, higher temperature, light, chemical structure of fat, occurrence of pro- or antioxidants.

Some fats (like oils) contain higher amount of unsaturated fatty acids and are more sensitive to such changes. The oxidative fat rancidity starts with increasing the amount of compounds in the nature of peroxides. Early determination of peroxide value allows to elaborate the optimal method for technological utilisation of fat raw material, and to identify undesirable changes of fat fraction.

The peroxides formation is associated with the creation of free radicals, which, in the opinion of physicians, are not neutral for human health, and can stimulate development of some dangerous diseases [3].

Changes of peroxide values for all examined sausages are showed in [Table 3](#).

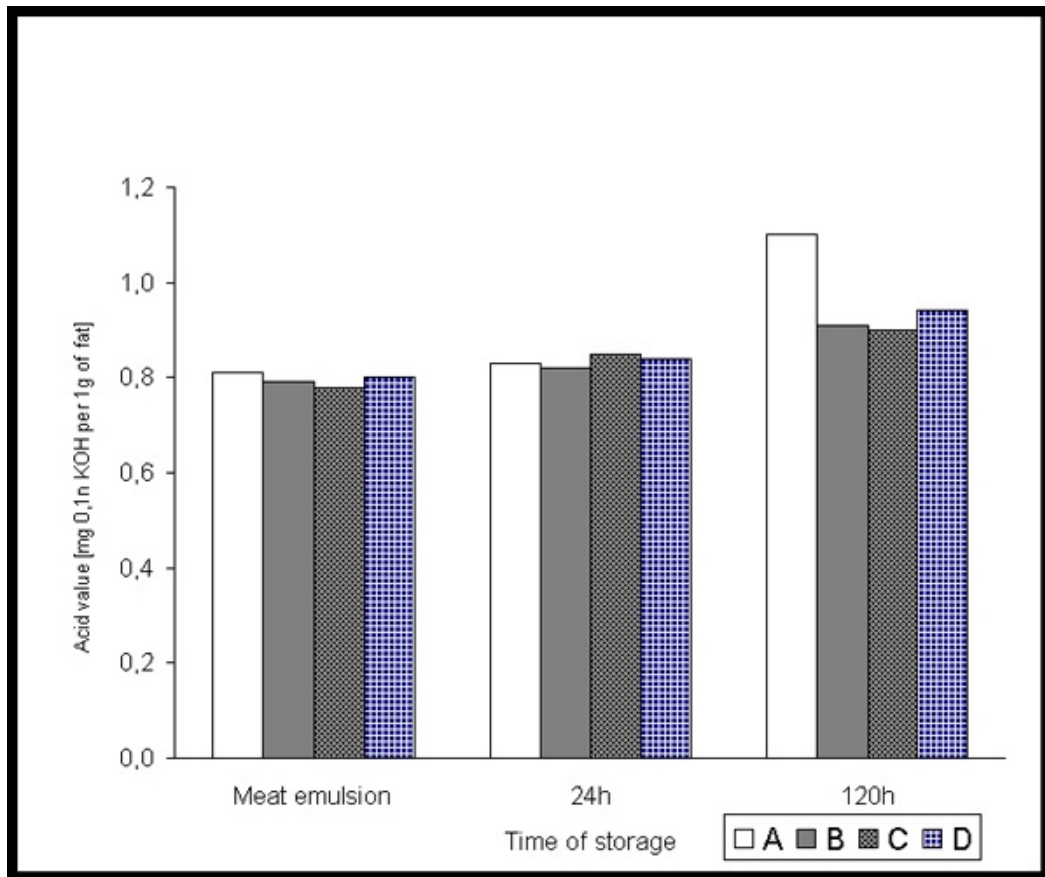
**Table 3. Peroxide values of fat in examined sausages [ml 0.002n Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>/1g of fat]**

Code of product	Time of storage (hours)		
	Meat emulsion	24h	120h
A	1.51	1.60	1.62
B	1.60	1.68	1.71
C	1.58	1.60	1.73
D	1.71	1.58	1.89

The most dynamic oxidative changes of fat quality measured directly after the end of the production process was observed for meat emulsions from group D (LN equal to 1.71). After 24 h of chilled storage of sausages, the highest peroxide value was found for sausage B, while after 120 h the highest value of this parameter was demonstrated for sausages from group D (50% of animal fat substitution by oil). Changes of peroxide value were slowest for sausages from group A (both measured after 24 h as well as after 120 h of chilled storage of the sausages). The results clearly indicate the increasing of oxidative fat changes during long term storage of experimental sausages. As far as the technological aspects are concerned, but also from nutritional and biological points of view, these changes are not desirable and can lead to negative changes of organoleptic characteristics of final meat products (in particular, taste and flavour).

The rate of hydrolytic changes of fat in experimental scalded sausages was assessed by determination of acid value (LK). Changes of this parameter are showed in [figure 1](#). Due to the Polish standard, fresh fat is characterised by acid value below 0.85 mg KOH/1 g of fat. For all sausages examined in this experiment this limit value was never exceeded. The values of LK varied within the range from 0.78 mg KOH/1 g of fat (meat emulsions) to 1.1 mg KOH/1 g of fat (sausages from group A, after 120 h of storage).

**Fig. 1. Acid value of investigated sausages.**



### 3. Sensoric evaluation of experimental sausage

The results of sensoric examination of all experimental sausages were presented in [Table 4](#).

**Table 4. Sensoric examination of model sausages (n=5).**

Factors	Code of product							
	A		B		C		D	
	24h	120h	24h	120h	24h	120h	24h	120h
Taste	4.8	4.8	4.8	4.8	4.6	4.6	4.2	4.2
Odour	4.7	4.8	4.6	4.8	4.6	4.6	4.2	4.2
Consistency	4.5	4.5	4.5	4.5	4.4	4.4	4.1	4.0
Cross - section colour	4.8	4.8	4.8	4.8	4.7	4.6	4.0	4.0

Generally, it was found that the overall consumer acceptance of examined sausages was influenced significantly ( $p = 0.05$ ) by the level of substituted fat. No worsening effect on the final sausage quality was observed for substitution levels below 35%. On the basis of the obtained results (including observations from initial experiments), the technological usability of rape oil as a substitute for a significant part of animal fat tissue in the production of finely comminuted sausages was confirmed. Any use of plant origin oil in the amount above the recommended level of fat substitution will lead, first of all, to significant changes of taste, flavour and consistency of final meat products and seems to be possible for significant technological modifications only. Additional costs should be taken into consideration in taking such decisions, too.

## CONCLUSIONS

1. The partial substitution of animal fat by rape oil in the production of finely comminuted sausages ("Parówkowa" type) offers a possibility to obtain final products demonstrating the quality, fully acceptable by consumers.
2. No significant negative effect of animal fat substitution below the level of 35% was observed with respect to cooking losses and selected sensoric parameters of the final product (cross-section, taste, flavour, consistency).
3. No worsening effect was found with respect to fat quality during production and chilled storage of final meat products contained rape oil.
4. It is recommended that the experiments focussed on technological usability of different plant origin fats in manufacturing finely comminuted meat products should be continued.

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