ROLE OF THE CHOSEN DIETARY FIBRE PREPARATIONS IN SHAPING OF STRUCTURE AND QUALITY OF MODEL MEAT PRODUCT

Makała H. and Olkiewicz M.
Meat and Fat Research Institute, ul. Jubilerska 4, 04-190 Warszawa, Poland

Background

The interest of the aware consumers towards food products with specific health-promoting properties, is not decreasing (Bacers, Noll 1998). Food products, containing such components as dietary fibre (Cludesdale 1997, Cieślik, Topolska 2002) satisfy some of these expectations.

Wheat and oat fibre preparations of the newest generation are characterized by a neutral flavour (taste and smell) and a high water binding capacity. Owing to its chemical structure, dietary fibre may absorb water to its capillary system and distribute it throughout the whole volume of the product via a generated three-dimensional network. In this study, the network of fibres, created with added dietary fibre is introduced in the matrix of finely comminuted sausage batter.

Objectives

The aim of the undertaken work was to determine the role of the chosen dietary fibre preparations, applied as a fat replacer and as a functional additive in shaping of structure and quality of a model meat product.

Materials and methods

The studied dietary fibre preparations were: wheat (WF 600-30) and oat (HF 600-30), which were applied to finely comminuted cooked meat product. The evaluation of the application of the chosen dietary fibre preparations as fat replacers was carried out, exchanging 30 % of the formulation fat. Hydrated preparations were introduced to the batter at a preparation to water ratio of 1 to 3.5. The functional role of the dietary fibre preparations in the system of finely comminuted meat product was examined, introducing them as a functional additives at a quantity of ca 1.5 % of total batter weight.

The raw material of the model meat product consisted of the tendinous pork meat (21.4 %), lean beef meat (28.6 %), fine pork fat (21.4 %) and water (28.6 %). The control product had the same composition, but without added dietary fibre (variant K). The products were manufactured according to typical production technology of bologna sausage. The tins were filled with 400 g of sausage batter, cooked in water (75^{o}C) until core temperature of 72^{o}C was reached. After cooking, the tins were chilled in cold water and stored refrigerated at +4 – 6^{o}C until the test samples were collected.

After removal of fat and jelly, basic chemical composition of the products was analysed, ie., water, protein, fat, and sodium chloride. The energy value of the product, expressed in kcal/100 g, was also calculated. The binding capacity of the product was evaluated as cooking losses, as well as slice strengths determined mechanically with the Zwick apparatus, model 1445 MOPS (Tyszkiewicz, Olkiewicz 1991).

The texture profile was tested by the instrumental TPA method (Crystall et al. 1994) and hardness, springiness, gumminess, cohesiveness and chewiness were characterized. The parameters of the testing instrument were as follows: deformation – 80 %, speed of the test – 60 mm/min, thickness of the sample – 20 mm and diameter – 25.4 mm.

The rheological characteristics ie., plasticity, elasticity and fluidity, were determined by Continuously Stress-Relax Analysis (CASRA) method, with the application of Universal TestinG Machine (UTM) Zwick, model 1445 MOPS (Tyszkiewicz, Olkiewicz 1997).

The desirability of colour, taste and texture and overall palatability of the product were evaluated as well. The sensory evaluation was performed in a specific laboratory by a professional panel of 8 members. The facility meets the requirements of standard ISO 8589, and uses the computer system ANALSENS.

Two experimental series of production for all variants were carried out. Chemical composition, textural profile, and sensory evaluation were repeated twice for each experiment. The values of the remaining variables are the means of either 5 (cooking loss) or 10 (slice strength) repetitions. The results of the tests were subjected to one-way analysis of variance using Statgraphics for Windows ver. 3.1.

Results and discussion

The effect of the added dietary fibre (wheat - W, oat - O) preparation used as fat replacers (R) and as functional additives (F) on basic chemical composition of the model meat product is presented in Table I.

Table I. Effect of dietary fibre used as a fat replacer (R) and as a functional additive (F) on the basic chemical composition of model meat products

Application of dietary fibre preparation:	Variant	Water [%]	Fat [%]	Total protein [%]	Energy value [kcal/100g]	NaCl [%]
fat replacer (R)	K	63.9 ^{a}	23.7 ^{b}	10.3 ^{a}	254.6 ^{b}	1.45 ^{c}
	WR	66.7 ^{b}	19.5 ^{a}	10.5 ^{ab}	220.5 ^{a}	1.39 ^{b}
	OR	65.5 ^{ab}	20.2 ^{a}	10.6 ^{b}	226.0 ^{a}	1.33 ^{a}
	NIR	*1.8*	*2.1*	*0.2*	*19.1*	*0.03*
functional additive (F)	K	63.9 ^{c}	23.7	10.3	254.6	1.45
	WF	62.8 ^{b}	23.4	10.1	252.2	1.46
	OF	62.0 ^{a}	23.8	10.1	256.6	1.43
	NIR	*0.8*	*0.9*	*0.3*	*8.8*	*0.05*

Means in the same column with different superscript are significantly different (P≤0,05)

The dietary fibre preparations used as fat replacers (WR, OR) had a significant effect on lowering of fat content, energy value and NaCl content as well as on the increasing of the contents of water and protein of the product. The dietary fibre preparations, when introduced as functional additives (WF, OF), did not have any other significant effect on the basic chemical composition than lowering the water content of the product, as compared to the control variant.

Table II. Effect of the dietary fibres, used as a fat replacer (R) and as functional additive (F), on the binding capacity and textural parameters of the sausage.

Application of dietary fibre preparation:	Variant	Cooking loss [%]	Slice strength [N/cm^2]	Hardness [N]	Gumminess [N]	Chewiness [Nmm]
fat replacer (R)	K	3.84 ^{a}	3.08	71.4 ^{a}	11.9 ^{a}	53.14 ^{a}
	WR	6.91 ^{b}	3.07	84.6 ^{b}	14.6 ^{b}	65.1 ^{b}
	OR	8.83 ^{c}	3.22	80.6 ^{b}	13.8 ^{b}	63.1 ^{b}
	NIR	*1.57*	*0.52*	*6.5*	*1.4*	*8.6*
functional additive (F)	K	3.84	3.08	71.4 ^{a}	11.9 ^{a}	53.1
	WF	3.43	3.33	79.7 ^{b}	13.4 ^{b}	59.3
	OF	4.05	3.64	83.0 ^{b}	13.6 ^{b}	58.2
	NIR	*0.63*	*0.70*	*5.1*	*1.4*	*10.2*

Means in the same column of with different superscript are significantly different (P≤0,05)

Water binding capacity of the model product was evaluated in terms of cooking loss and slice strength (Tab. II). When used as fat replacers (WR, OR), the dietary fibre preparations caused a significant increase of cooking loss, yet a good slice strength not differing from the control product. The highest cooking loss was found in the product, in which dietary oat fibre replaced 30 % of the fat in the formulation. As functional additives (WF, OF), the studied preparations did not have any significant effect on water binding of the product.

When used as fat replacers (WR, OR), the dietary fibre preparations increased the textural measures of hardness, gumminess and chewiness significantly (Tab. II). Except for chewiness, this was also the case when fibre was used as a functional additive (WF, OF), they had a significant influence on the increase of hardness and gumminess. Products with added fibre (WR, OR, WF, OF) did not differ significantly from the controls for the remaining texture parameters, not found in the table.

Table III. Effect of dietary fibre as a fat replacer (R) and as functional additive (F) on the rheological characteristic

Application of dietary fibre preparation	Variant	Plasticity [$x10^5 N/m^2$]	Elasticity [$x10^{-6} m^2/N$]	Fluidity [$x10^{-8} Nm^2/Ns$]
fat replacer (R)	K	2.36	1.14	3.25
	WR	2.70	1.06	3.08
	OR	2.57	1.04	3.16
	NIR	*0.39*	*0.16*	*0.57*
functional additive (F)	K	2.36 [a]	1.14 [b]	3.25
	WF	2.60 [b]	1.01 [a]	3.26
	OF	2.66 [b]	0.99 [a]	3.07
	NIR	*0.16*	*0.12*	*0.50*

Means in the same column with different superscript are significantly different (P≤0,05)

The substitution of fat with dietary fibre did not have any significant effect on rheological characteristic of the products (Tab. III). The dietary fibre preparations, employed as functional additives (WF, OF) caused a significant increase of plasticity, with the simultaneous significant decrease of elasticity, in comparison to the control products.

Table IV. Effect of dietary fibre as a fat replacer (R) and as functional additive (F) on sensory parameters

Application of dietary fibre preparation	Variant	Colour desirability [c.u.]	Taste desirability [c.u.]	Texture desirability [c.u.]	Overall palatability [c.u.]
fat replacer (R)	K	5.0	5.3	5.2	5.6
	WR	5.0	5.3	5.4	5.5
	OR	5.2	5.0	5.1	5.2
	NIR	*0.7*	*0.5*	*0.4*	*0.6*
functional additive (F)	K	5.0	5.3[ab]	5.2	5.6
	WF	4.8	5.0[a]	5.3	5.3
	OF	5.2	5.4[b]	5.4	5.5
	NIR	*0.8*	*0.3*	*0.4*	*0.5*

Means in the same part of column with different superscript are significantly different (P≤0,05)

In spite of their role in texture, the employed dietary fibre preparations did not play any significant role in sensory desirability (Tab. IV). The taste of the product containing oat fibre (OF) was preferred over that containing wheat fibre.

Meat products with a different type of dietary fibre preparation (wheat or oat) did not differ significantly from each other in terms of physiochemical parameters, texture, rheological or sensory properties.

For most characteristics evaluated, the products with added fibre did not differ from the control samples in quality. Also in earlier studies, in which wheat fibre of earlier generation was used as a fat replacer, Makała (2002a,b) found that the examined products had characteristics, such as structure, binding capacity and sensory desirability, similar to those of the controls. Dietary fibre used as a fat replacer produced better sensory quality than reported in the earlier protein - polysaccharide systems (Olkiewicz, Kostyra, Adamik 1998). A significant increase in cooking losses is a drawback of using dietary fibre preparations as fat substitutes, as also reported in earlier studies of Egbert (1991) and Keeton (1992).

To receive all benefits of added dietary fibre in meat products ie., desirable nutritional function as well as their favourable role in sensory quality, further studies are needed to optimize their application in fat substitution or functional administration.

Conclusions

1. Dietary fibre preparations used to replace 30% of fat caused a significant increase of cooking loss, whereas the slice strength and rheological quality did not differ from the control products.
2. The products containing 1.5 % of wheat or oat fibre were characterized by better binding capacity, sensory palatability and hardness than the control product. At the same time the product received nutritional value in the form of dietary fibre, which is known to promote the health of human gastro-intestinal tract.
3. Wheat and oat fibre may be used as fat replacers and functional additives without compromising the sensory and textural quality of finely comminuted cooked meat products.

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