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Sensory Evaluation of Sausages with Various Proportions of *Cyprinus carpio* Meat

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Abstract

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The heat-treated sausages with a proportion (30%, 45%, 60%) of common carp (*Cyprinus carpio* L.) meat was evaluated. The products were subjected to sensory evaluation (cold: max. +4°C, heated in water: 90°C/15 min, grilled: 200°C/15 min) and compared with a control (0%, without the addition of fish). There are demonstrated a reduced preference for sausages in dependence on the increasing proportion of fish material in the product. This trend was most pronounced for the factors consistency, overall appearance, general impression, sliced appearance, and tenderness. The method of cooking led to even more pronounced differences. The results showed that this type of product may be produced using ordinary technological processes and that sausages with a proportion of carp meat may be of extremely high quality in nutritional terms and attractive as a food to the consumer.

Keywords: organoleptic quality; fish product; consumption of fish meat

Fish products such as sausages, salamis, frankfurters, burgers, and kebabs have been the subject of research in recent years, particularly in the countries of eastern Asia and in a number of other countries around the world. Fillet muscle or less expensive mechanically separated fish meat and its "surimi" processing are used as raw ingredients (Rahmanifarah *et al.* 2013). Isolates of proteins or fats obtained from fish by the isoelectric solubilisation/precipitation method are a possible alternative (Taskaya *et al.* 2009). Products are made from 100% fish material or various proportions (0, 20, 40, 60, and 80%) of minced fish meat from *Oreochromis niloticus* (De Oliveira Filho *et al.* 2010) in combination with the meat of terrestrial animal species (e.g. Berik & Kahraman 2010). In this study two different groups of sausages (100% of fish meat from *Mugil cephalus*, the second group: 75% of fish with 25% of calf meat) were produced. Fresh sausages and those cooked by deep fat-frying techniques were investigated for sensory changes and nutrient composition. Sensory and chemical characteristics of sausages produced from cyprinid meat (from *Cyprinus carpio*, *Hypophthalmichthys molitrix*, *Ctenopharyngodon idella*) were evaluated in the study of Okanović *et al.* (2013), textural, physical, and sensory properties of sausages which were prepared from refrigerated and frozen *Onchorynchus mykiss* were presented by Dincer and Cakli (2010). Sensory analysis was performed to determine the consumer preferences to fish sausages prepared in Turkey.

To date, no one in the Czech Republic has been engaged in any scientific research focusing on this area of the food industry. The absence of any scientific results on this subject is therefore evident. Consumption of fish is extremely low in the Czech Republic (around 5 kg per capita per year), with the traditional eating habits of the average member of the population largely involving the consumption of pork and poultry, and fish being perceived as a traditional symbol of Christianity and Christmas. Fish products such as sausages and frankfurters are,

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however, commonly produced for domestic production in the families of fishermen. It is therefore only a question of time as to when the consumer in the Czech Republic expresses a commercial interest in this type of fish product. It can therefore be anticipated that the diversification of the range of fish products on offer will be based on the processing of carp meat and the development of new products made from this species of fish.

For this reason, the aim of this work was to produce experimental samples of sausages with various proportions (30, 45, and 60%) of common carp (*Cyprinus carpio* L.) meat, and to subject the final products to sensory evaluation.

MATERIAL AND METHODS

Fillets of the common carp (*Cyprinus carpio* L.) were used for the production of experimental sausages with varying proportions (30, 45, and 60%) of fish meat. The fish were purchased live on the retail market. The fish were killed and processed (gutting, skinning, filleting, manual removal of bones from the fillets). The experimental sausages were made at the Technology Workshop at the Department of Meat Hygiene and Technology at the Faculty of Veterinary Hygiene and Ecology at the University of Veterinary and Pharmaceutical Sciences Brno, Czech Republic. Preparation of raw materials: 1 kg of 30% sausages: 30% fish + 70% pork; 45%: 45% fish + 55% pork; 60%: 60% fish + 40% pork (the term fish means: carp fillet and pork means: 90% of only lean pork shoulder and 10% of pork backfat). Additives and seasoning mix: nitrite salting mix E 250 (180 g/kg), garlic (16 g/kg), antioxidant Sodium Erythorbate E 315 (1 g/kg) and the seasoning mix SCZA 04006 Sausage Franta Excelent Solo from the company TRUMF International s.r.o., Dolni Ujezd, Czech Republic (4 g/kg)) and potable water 0.1 l/kg) were also used. Control samples of sausage (0%) were made without fish meat (100% of pork). Pig intestine served as a casing. The samples of sausages were made using an ordinary technological procedure that consists of the following steps: preparation and weighing of raw materials, grinding, salting, mixing, pushing, cooking at 70°C for 10 min, smoking (beech wood) for 2.5 h, cooling by cold water. A total of 5 various batches were made. The samples of sausage were analysed the day after production.

Sensory evaluation was performed in a laboratory in accordance with the requirements of the legal standard ČSN ISO 8589:2008 by a panel of 10 trained persons. The evaluation was done by employees (6 holders of the Sensory Attest Certificate according to Organizational Directive No. 026/2003 of the Czech Agriculture and Food Inspection Authority) and by 4 post-graduate students on the study programme Food Hygiene and Technology of FVHE Brno, Czech Republic (the students were previously acquainted with the sensory protocol and trained in sensory analysis and they were familiar with the problems of fish sausage assessment). The products were submitted to the assessors cold (max. +4°C), heated in water (90°C/15 min), and grilled (200°C/15 min). A protocol with unstructured graphic scales of 100-mm length was used during sensory evaluation, with one end of the scale representing a completely satisfactory state of the parameter in question and the other end an entirely unsatisfactory state for the given parameter. The assessors evaluated 10 parameters: overall appearance, consistency, tenderness, appearance on the cut surface, odour, fishy smell* and fishy taste*, taste (with an emphasis on saltiness), spicy intensity of seasoning, and general impression. An emphasis was laid on the acceptability of the sensation for the parameters fishy smell and fishy taste.

The results of the tests performed were evaluated (mean ± SD) in the Excel 2007 programme and statistically significant differences in the values of parameters and type of preparation for sensory evaluation were further determined at significance levels of $\alpha = 0.05$ ($P < 0.05$) and $\alpha = 0.01$ ($P < 0.01$) by the UNISTAT 6.0.05 programme (Unistat® Ltd, London, UK).

RESULTS AND DISCUSSION

The results of the sensory evaluation of sausages served cold (max. +4°C) are given in Figure 1a. The specific values (mean ± SD) of monitored parameters including results of statistical evaluation are shown in Table 1. The highest point score for all 10 parameters monitored was for the control samples of sausage (0%). The point score given to the individual parameters fell with the increasing proportion of fish (30, 45, 60%) in the sausages. No statistically significant differences in the sensory evaluation between the control sausages (0%) and the samples with a 30% and 45% proportion of fish were found out, with the exception of the evaluation of the parameter fishy taste ($P < 0.05$) between the control (0%) and the sausages

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with a 30% proportion of fish. Significant differences were found out only between the control (0%) and the sausages with a 60% proportion of carp meat, for the parameters overall appearance, consistency, fishy taste ($P < 0.01$), and fishy smell ($P < 0.05$). The samples of experimental sausages (30% vs. 45%, 30% vs. 60%, 45% vs. 60%) served cold were perceived identically by the assessors, with no demonstrable differences in the scores given for the individual parameters. However, the sensory preference fell with the increasing proportion of fish meat used, as can be seen from the number of points attributed. Parameters such as consistency, tenderness, and sliced appearance were generally evaluated as the least acceptable of all the parameters tested (Figure 1a).

The results of the sensory evaluation of sausages heated in water (90°C/15 min) are given in Figure 1b. The specific values (mean ± SD) of monitored parameters including results of statistical evaluation are shown in Table 1.

The sausages with a 30% proportion of carp appeared the same in sensory terms as the control (0%) to the assessors when heated. The 30% proportion of fish was reflected in a higher score (+ 3 points) in comparison with the control (0%) in relation to the parameter odour, though this was not statistically significant. The point scores for other parameters were lower for 30% sausages. Heating the sausages increased the perception of certain parameters evaluated by the assessors, particularly in experimental samples with a 45 and 60% proportion of fish. Sausages with a 45% proportion of carp meat differed significantly ($P < 0.05$) from the control sausages (0%) in relation to three parameters: consistency, fishy taste, and general impression. As was the case for samples served cold, statistically significant differences were found in heated sausages (90°C/15 min) between the control (0%) and sausages with a 60% proportion of carp meat for the parameters general impression, consistency ($P < 0.01$), overall appearance, sliced appearance, and fishy smell ($P < 0.05$). Between the samples of experimental sausages, sporadic significant differences in point scores were found for the parameters consistency, sliced appearance, and general impression (samples 30% vs. 60%); consistency and general impression (samples 45% vs. 60%). The assessors attributed the lowest scores to the sausages with a 60% proportion of fish for the parameters consistency (42 points) and sliced appearance (61 points).

The results of the sensory evaluation of grilled sausages (200°C/15 min) are given in Figure 1c. The specific values (mean ± SD) of monitored parameters including results of statistical evaluation are shown in Table 1.

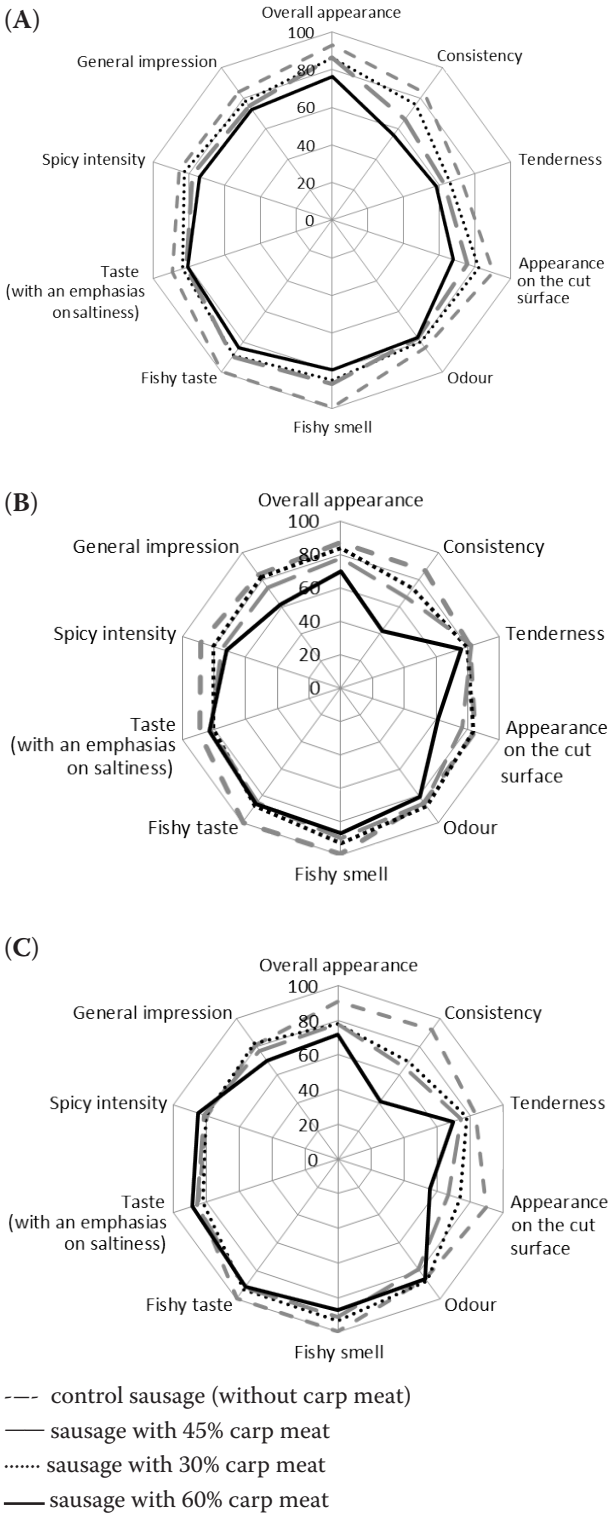

Figure 1. The results of sensory evaluation of sausages (**A**) served cold (max. +4°C), (**B**) heated in water (90°C/15 min), and (**C**) grilled sausages (200°C/15 min)

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Table1. Sensory analyses of differently processed sausages

Type of sausage and adjustment method	Carp meat (%)	Overall appearance	Consistency	Tenderness	Appearance on the cut surface	Odour	Fishy smell	Fishy taste	Taste (with an emphasis on saltiness)	Spicy intensity	General impression
Served cold (max. 4°C)	0	93 ± 4^{b}	84 ± 10^{b}	72 ± 14^{a}	90 ± 5^{a}	84 ± 5^{a}	100 ± 1^{b}	100 ± 0^{b}	89 ± 4^{a}	86 ± 5^{a,1,2}	84 ± 9^{a}
	30	86 ± 3^{ab}	76 ± 7^{ab}	66 ± 4^{a,1}	82 ± 9^{a}	80 ± 9^{a}	85 ± 6^{ab}	89 ± 4^{ab}	84 ± 9^{a}	83 ± 12^{a}	78 ± 1^{a}
	45	87 ± 5^{ab}	66 ± 12^{ab}	63 ± 8^{a,1}	76 ± 9^{a}	78 ± 10^{a}	87 ± 9^{ab}	90 ± 7^{ab}	82 ± 5^{a}	78 ± 11^{a}	75 ± 3^{a}
	60	76 ± 7^{a}	56 ± 2^{a,3}	58 ± 7^{a}	68 ± 15^{a}	77 ± 3^{a}	80 ± 9^{a}	84 ± 4^{a}	81 ± 7^{a}	74 ± 14^{a}	73 ± 5^{a,2}
Statistical significant*		$P < 0.01$	$P < 0.01$	–*	–*	–*	$P < 0.05$	$P < 0.01$	–*	–*	–*
Heated in water (90°C/15 min)	0	87 ± 5^{b}	87 ± 2^{b}	81 ± 12^{a}	85 ± 4^{b}	85 ± 9^{a}	100 ± 0^{b}	100 ± 0^{b}	89 ± 1^{a}	88 ± 1^{a,2}	84 ± 5^{b}
	30	84 ± 5^{ab}	74 ± 11^{b}	80 ± 4^{a,2}	84 ± 8^{b}	88 ± 4^{a}	94 ± 2^{ab}	88 ± 7^{ab}	80 ± 12^{a}	81 ± 11^{a}	82 ± 4^{b}
	45	78 ± 7^{ab}	67 ± 4^{b}	82 ± 4^{a,2}	77 ± 12^{ab}	86 ± 7^{a}	90 ± 4^{ab}	85 ± 6^{a}	83 ± 6^{a}	76 ± 11^{a}	74 ± 2^{b}
	60	70 ± 10^{a}	42 ± 8^{a,2}	76 ± 8^{a}	61 ± 10^{a}	81 ± 8^{a}	87 ± 7^{a}	86 ± 7^{ab}	83 ± 6^{a}	72 ± 17^{a}	62 ± 1^{a,1}
Statistical significant*		$P < 0.05$	$P < 0.01$	–*	$P < 0.05$	–*	$P < 0.05$	$P < 0.05$	–*	–*	$P < 0.01$
Grilled (200°C/15 min)	0	91 ± 3^{a}	92 ± 2^{c}	84 ± 7^{a}	90 ± 3^{b}	86 ± 8^{a}	100 ± 0^{b}	99 ± 1^{b}	85 ± 4^{a}	80 ± 3^{a1}	81 ± 5^{b}
	30	78 ± 15^{a}	69 ± 14^{bc}	78 ± 4^{a,1,2}	74 ± 15^{ab}	87 ± 7^{a}	93 ± 4^{ab}	93 ± 2^{a}	82 ± 5^{a}	81 ± 5^{a}	82 ± 4^{b}
	45	78 ± 12^{a}	65 ± 6^{b}	74 ± 10^{a,1,2}	67 ± 10^{ab}	79 ± 9^{a}	91 ± 4^{ab}	92 ± 2^{a}	86 ± 5^{a}	82 ± 11^{a}	77 ± 3^{ab}
	60	72 ± 17^{a}	41 ± 2^{a,1,2}	70 ± 10^{a}	56 ± 13^{a}	86 ± 7^{a}	88 ± 5^{a}	91 ± 2^{a}	89 ± 6^{a}	85 ± 6^{a}	70 ± 6^{a,1,2}
Statistical significant*		–*	$P < 0.01$	–*	$P < 0.01$	–*	$P < 0.01$	$P < 0.01$	–*	–*	$P < 0.05$
Statistical significant**	0	–*	–*	–*	–*	–*	–*	–*	–*	$P < 0.05$	–*
	30	–*	–*	$P < 0.05$	–*	–*	–*	–*	–*	–*	–*
	45	–*	–*	$P < 0.05$	–*	–*	–*	–*	–*	–*	–*
	60	–*	$P < 0.05$	–*	–*	–*	–*	–*	–*	–*	$P < 0.05$

Statistical significant: *differences among control group (0%) and groups with different addings of fish meat (30%, 45%, 60%); groups with a different alphabetic superscript $^{a–c}$in columns differ significantly at $P < 0.05$ or $P < 0.01$; ** differences among different thermal adjustments of sausages for each group (0%, 30%, 45%, 60%) separately; groups with a different numerical superscript $^{1–3}$in columns differ significantly at $P < 0.05$; data with common alphabetic or numerical superscripts do not differ significantly at the given level

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The high temperatures during grilling had the greatest negative effect on the parameter consistency, which was reflected in a low point score being attributed for this parameter and the existence of statistically significant differences for the experimental sausages (30% – 69 points, $P < 0.05$; 45% – 65 points, $P < 0.01$; 60% – 41 points, $P < 0.01$) in comparison with the control (0% – 92 points). Differences ($P < 0.01$) between the control samples (0%) and the samples with a proportion of fish (30, 45, and 60%) were also found out for the parameter fishy taste. The sausages with 45% carp meat also differed in relation to the parameter fishy smell ($P < 0.05$) from the controls (0%), while the sausages with the highest proportion of fish (60%) also differed in relation to other parameters: sliced appearance ($P < 0.01$), fishy smell ($P < 0.01$), and general impression ($P < 0.05$). Sporadic significant differences in point scores were revealed between the samples of experimental sausages in relation to the parameters consistency (samples, $P < 0.01$; 30% vs. 60%, 45% vs. 60%) and general impression (samples, $P < 0.05$; 30% vs. 60%).

Statistical significant differences between different heat treatments of sausages for each group (0, 30, 45, and 60%) separately are shown in Table 1.

Contrary to our expectations the culinary treatment methods of sausages – served cold (max. 4°C), heated in water (90°C/15 min), grilled (200°C/15 min) – had no significant effects on sensory parameters. The control samples of sausages without addition of fish meat (0%) had similar values regardless of the culinary treatment. A significant difference ($P < 0.05$) was detected for spicy intensity parameter, when grilled sausages obtained a lower level (80 points) in comparison with sausages prepared by heating in water (88 points). Experimental samples of sausages with 30% and 45% of carp meat showed similar results. A significant difference ($P < 0.05$) was detected only for tenderness parameter – sausages treated by heating in water obtained a higher score than sausages served cold (max. 4°C). The most significant differences ($P < 0.05$) were noted between sausages with the highest addition of fish meat (60%), particularly in consistency and general impression parameters – sausages served cold obtained more points than grilled sausages and sausages heated in water.

The results of the sensory evaluation show that the number of points attributed to the individual parameters fell with the increasing proportion of fish in the sausages (30, 45, and 60%). This trend was most evident for the parameters consistency, general appearance, overall impression, sliced appearance, and tenderness. The method of cooking deepened these differences, which is associated with the greater sensitivity of man's senses in perceiving specific chemical substances referred to as "fishy smell or taste" which are volatile in nature in warm or hot samples (e.g. trimethylamine). The lower point scores given for the parameter consistency in hot sausages with a proportion of carp is probably associated with other technological properties of fish meat and a change in the thermal stability of aromatic collagen proteins as a result of heat (heating in water, grilling).

Okanović *et al.* (2013) reported the results of sensory evaluation of fish sausages before heating, after cooking, and after roasting. Sensory properties were typical of fish sausages, odour and taste were without foreign impurities. There was not any deformation on the product surface, the collagen casing was adhered to the stuffing published. The most acceptable flavour of sausages was after roasting, unfortunately the starchy flavour and grainy texture were more pronounced. In their study Dincer and Cakli (2010) published that sausages prepared from frozen fillets exhibited a significantly ($P < 0.05$) weaker texture than those prepared from refrigerated fillets, but no difference in overall liking was observed. Both groups received scores of over 8 on a 1–9 point hedonic scale and had similar colour values. According to these authors the fish sausages can be considered healthy for Turkish consumers, they recommend that the children and elderly people should be target consumers. In the study of De Oliveira Filho *et al.* (2010) the texture parameters decreased with the increasing inclusion of minced Nile tilapia fish. The sensory evaluation of the colour showed that the maximum level (100%) of inclusion of minced meat was not well accepted by the panellists. The sausages with the best acceptance for the flavour attribute were those with 60% of minced fish.

In view of the low popularity of fish in the Czech Republic, the lower point scores attributed to the "fish" sausages were not surprising. When developing innovated cooked or fermented products made from fish or products with a proportion of fish, it will be necessary to take into account a level of suspicion among the population of the Czech Republic and to verify their potential consumer acceptability with the help of sensory evaluation of the final products in a similar way to that employed in the work of Raksakulthai *et al.* (2004). The preferences of

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consumers throughout the population may not, however, be identical, with a role being played by age, gender, occupation, education, and lifestyle. This is shown by the results of the work by the team Raksakulthai *et al.* (2004), who evaluated differences in tests on the acceptability of two fish products (fish balls and fish frankfurters) performed by a diverse group of assessors (fishermen, housewives, retailers, students, caterers, farm workers). Cultural habits may also have an influence on the acceptability of fish products (Raju *et al.* 2003), which is another aspect that may significantly modify the interaction between the commercial supply of fish sausages and demand for them from consumers in the course of the year. Interest in freshwater fish is seen primarily at Easter and Christmas, while demand for products such as sausages reaches a peak in the summer (garden parties).

Xu *et al.* (2010) used sensory evaluations to examine the inception and development of undesirable (acidic odour, taste) organoleptic properties, including characteristics typical of fish products, in experimental sausages made from the silver carp (*Hypophthalmichthys molitrix*) with an addition of starter culture fermented at various temperatures (15, 23, 30, and 37°C). Sensory evaluation (appearance, consistency, aroma, taste, juiciness), as a widely used method in scientific research, was also used for the evaluation of three types of fish products by Egbal and Ghada (2011), who tested fish sausages made from *Clarias lazera*, *Tetradon fahaka* and a 1 : 1 mixture of the two fish species. Raksakulthai *et al.* (2004) also tested their experimental fish products (hybrid *Clarias catfish*) under various conditions (e.g. produced with the use of pork lard, palm oil, various types of seasoning, dried for varying periods) with the use of sensory evaluations.

Surprisingly, there was a limited presence of statistically significant differences between values within the measured parameter regarding the method of culinary preparation of sausages (served cold, heated in water, grilled) as shown in Table 1. However, these findings are very favourable for consumers. With respect to the negative feelings of Czech consumers about fishy smell we aimed to find the most suitable method of thermal processing for serving of sausages containing fish meat, as differences mainly in odour, fishy smell, and fishy taste were expected between the experimental groups containing different amounts of fish meat (0, 30, 45, and 60%). Generally, meat and meat products processed at higher temperatures (e.g. grilled) develop more intensive odour and taste, because these temperatures lead to a non-enzymatic reaction between reducing sugars (or products of their degradation) and amino acids (or proteins) and subsequently to development of the Maillard reaction compounds affecting aroma and taste (Petrović *et al.* 2011; Kouakou *et al.* 2014). On the other hand, addition of spices and thermal processing decrease the typical fishy smell, so only the typical fishy taste remains. What more, this fishy taste was not detected regardless of the culinary treatment of sausages. In the case of sausages with 30% and 45% of fish meat, their tenderness was more pronounced when prepared by heating in water than when served cold or grilled. Sausages containing 60% of carp meat are best if served cold, because the heat treatment enhances deficiencies in technological parameters of fish meat, leading to worse consistency and general impression of the sausages.

In conclusion, the market demands a range of innovated products with added value that will be interesting to consumers from the viewpoint of their composition and their biological and nutritional value.

The use of the common carp (*Cyprinus carpio* L.) meat in traditional sausage-type products made from pork may be one of the many possibilities for innovating products in the market in the Czech Republic. The possibility of introducing such products to the market of the countries of central Europe, which is saturated with products made from pork and poultry, is clear from the available literature describing the manufacture of such products around the world (Arihara 2006). Introducing and keeping innovated products with a proportion of carp in the market would make a significant contribution towards diversification of the range of freshwater fish products, while also making the use of fish, which is considered beneficial to the health, more effective (Steffens 1997).

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