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THE EFFECT OF HEMP SEED AND LINSEED ADDITION ON THE QUALITY OF LIVER PÂTÉS

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ABSTRACT

Background. Liver pâtés are popular all over the world, but they usually contain high amounts of animal fats. It may be beneficial to improve their dietetic value by decreasing the saturated fatty acid content, while maintaining their sensory quality. One way to do this is to add ingredients which are rich in polyunsaturated fatty acids, such as hemp seed or linseed. Hemp seeds are valuable because of their fat and protein content and linseed is known for its high α-linolenic fatty acid (ALA) content. Both are good sources of fiber.
Material and methods. Three pork liver pâtés were produced: one with hemp seed, one with both hemp seed and linseed and one with neither. The products were tested by 50 consumers, a proximate analysis was conducted and the fatty acid profile, texture and color of the pâtés were analyzed.
Results. The addition of hemp and linseed increased the fat content. The fatty acid profile improved significantly. There were more polyunsaturated fatty acids and the n-6 to n-3 ratio was reduced in both products containing oil seeds compared to the control sample, which is important from the health point of view. The color parameters were not changed. The hardness, chewiness and adhesiveness increased in products containing oil seeds. Those products received higher scores in sensory analysis.
Conclusions. The quality of the pâtés with added oil seed is comparable to or better than the traditional ones. The products with both hemp and linseed can be treated as a good source of n-3 fatty acids. The amount of ALA is high enough to label the product as a source of n-3 fatty acids.

Keywords: hemp seed, linseed, liver pâté, functional meat products

INTRODUCTION

Liver pâtés are consumed all over the world and are popular among consumers. They are usually made from various types of meat and fat, which are cooked and then minced and mixed with spices and other ingredients such as liver, carbohydrates or emulsifiers. Homogenized liver, if used raw, acts as an emulsifying ingredient, but it should not be used excessively to avoid a metallic and bitter aftertaste. Unfortunately, pâtés tend to contain high amounts of animal fat, which consists mostly of saturated fatty acids and cholesterol and is therefore considered unhealthy. Dietitians advise against consuming liver pâtés, although those products may be treated as a valuable source of vitamin A and iron (Terrasa et al., 2016). Currently, there is a trend to improve the nutritional value of fatty meat products by decreasing the fat content or replacing animal fat with unsaturated oils. This procedure may lead to undesirable technological

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and sensory changes (Delgado-Pando et al., 2011; Dominguez et al., 2017; Pintado et al., 2018). Consumers are willing to buy healthy foods with changed flavor only if the taste remains pleasant. People are interested in products which contain ingredients generally recognized as healthy, such n-3 fatty acids or fiber. Producers try to follow the market trends and new products are constantly appearing on the market, but there are still few functional meat products available (Shan et al., 2017).

The incorporation of additives to improve the nutritional value of the product may be another way to create a healthy meat product. Natural sources of polyunsaturated fatty acids (PUFA) which have already been tested are fish, olive, canola or linseed oil and many others (Delgado-Pando et al., 2011; Morales-Irigoyen et al., 2012; Pelser et al., 2007; Valencia et al., 2008; Youssef and Barbut, 2011). Thus, the aim of this study was to compare the effects of hempseed and linseed addition on the quality of liver pâtes. These seeds, apart from their valuable fat content, are also good sources of fiber, minerals and proteins.

MATERIAL AND METHODS

The production process

Three types of pâtés were manufactured: the control product (C), which did not contain any additional oil ingredients, the hemp seed product (H) containing hemp seed only and the hemp seed with linseed product (HL) containing both hemp seed and linseed (Table 1). The raw materials (pork shoulder and turkey thigh meat, pork jowl) were cut and cooked in boiling water for 1 h. The stock obtained during cooking was used in the next step of the production process. The liver was homogenized for 15 min with salt (NaCl) in a cutter (Robot Coupe R2, France) to obtain fine emulsion and then the meat stock, spices, cooked meat and fat (pork jowl), together with the oil ingredients, were added. The aluminum baking trays (500 ml) were filled with batter and baked for 1 h at 180°C. Hemp seed (*Cannabis sativa* L.) (variety Białobrzeskie SR79 cultivated in Poland) and linseed (*Linum usitatissimum*) (variety Sapphire-Szafir – BOH 191, cultivated in Poland) used in the production were ground using

Table 1. The composition of three variants of pâté, g

Raw materials and spices	Control pâté (C)	Pâté with hemp seeds (H)	Pâté with hemp seeds and linseeds (HL)
Poultry liver	100	100	100
Turkey thigh meat	250	250	250
Pork jowl	180	180	180
Pork shoulder	470	470	470
Salt NaCl	17	17	17
Onion	10	10	10
Nutmeg	4	4	4
Black pepper	4	4	4
Marjoram	4	4	4
Dried vegetables (carrot, celeriac, parsnip)	12	12	12
Linseed	0	0	50
Hempseed	0	100	100
Stock	600	600	600

a grinder (MPM MMK-02M, Poland). The experiment was repeated three times.

Proximate composition

Before the analyses, the pâtés were homogenized using an MPW-120 laboratory homogenizer (MPW Med. Instruments, Poland). After comminution, the samples were analyzed for water, protein (Kjeldahl method), fat (Soxhlet method after hydrolyzing the samples in acetic acid), and ash content, according to the official methods of the Analytical Chemists' Association (AOAC, 1995). All the analyses were conducted in duplicate.

Texture profile analysis

The texture profile analysis (TPA) of the samples was conducted as described by Palka (Palka and Daun, 1999). The samples were cut into 15 mm × 15 mm cubes. Measurements were conducted using a TA-XT2 (Stable Micro Systems, UK) texture analyzer with a cylindrical probe of 100 mm diameter, on the following settings; probe travel rate before testing: 5 mm/s, during and after testing: 2 mm/s; final strain: 50%; time interval between first and second stroke: 3 s. Six independent measurements were performed for each pâté.

Color assessment

The color of all the homogenized pâtés was measured using a Konica Minolta CM-3500d (Japan) spectrophotometer. The reflectance method was applied with the standard illuminant: D65 and observer angle: 10 degrees (diameter of the measuring hole: 8 mm). The CIE L^*, a^*, and b^* values (1976), were determined from the mean of six readings on the homogenized sample. Calibration was conducted on black glass, then a white enamel tile, according to the manufacturer's specifications.

Fatty acid profile

Fat was extracted from the samples and esterificated (Folch et al., 1957). Fatty acids were analyzed using a TRACE GC ULTRA gas chromatograph (Thermo Electron Corporation, Milano, Italy) and SUPELCOWAX 10 capillary GC column – phase: poly(ethylene glycol) (30 m × 0.25 mm × 0.25 μm film thickness). The carrier gas was helium, at a flow rate of 1 ml/min. Split flow was set at 10 ml/min. The injector port temperature was 220°C and the detector (FID): 250ºC. The column temperature was increased from 160°C to 210°C at a rate of 3°C/min. The temperature was maintained at 210°C for 25 min. Samples were injected along with the set of standards (fatty acid methyl esters). Individual fatty acid methyl esters were identified by comparison to the standard mixture (Supelco 37 Component FAME Mix, Bellefonte PA, USA) and to CLA isomers (Sigma-Aldrich Co., St. Louis, MO, USA). Fatty acids were identified and relative peak areas were calculated. The analyses were carried out in triplicate.

Consumer tests

The products were served to 75 people who graded them in a 9-point hedonic scale, in which 1 was described as "the least acceptable" and 9 – "most acceptable". Three coded products were given to each person on a plastic plate. The panelists were asked to evaluate: appearance, texture, moisture, smell, taste and overall acceptability.

Statistical analysis

All data was subjected to one way analysis of variance using STATISTICA 13 software. The normality of the results was established using the Shapiro-Wilk test. The Tukey test ($P < 0.05$) was used to locate significant differences between means. The results are presented as average values ±standard deviations.

RESULTS AND DISCUSSION

The quality of liver pâtés may be altered by the manipulation of the proportions of raw materials, the spices used and the thermal treatment. The last may concern the final product (baking or cooking in hot water) or the raw materials, which may be fried, boiled or baked. The proximate composition of commercial pâtés differs significantly, particularly in fat content. Liver pâtés may contain from 9–35 g of fat in 100 g of a product (Estevez et al., 2004; 2005; Tyburcy et al., 2005). The pâtés produced in this study contained 146–183 $g \cdot kg^{-1}$ of fat (Table 2). There was more extractable fat in the product containing hemp seeds and linseeds. There were no significant differences in protein or ash content among the pâtés. The water content decreased with the amount of oil seeds added.

Table 2. The proximate composition of the pâtés, g·kg^{-1}

Variant	Water	Fat	Protein	Ash
Control pâté (C)	665.10^{c} ±24.60	146.10^{b} ±24.40	159.70^{a} ±10.7	21.10^{a} ±1.10
Pâté with hemp seed (H)	628.50^{b} ±22.30	149.90^{b} ±6.20	169.50^{a} ±10.60	21.90^{a} ±1.00
Pâté with hemp seed and linseed (HL)	604.00^{a} ±9.70	183.40^{a} ±25.50	168.30^{a} ±10.20	22.00^{a} ±0.90

^{a,b} Different letters in columns indicate significant differences between means ($P < 0.05$; $n = 9$).

During the production of all the pâtés, the same amount of all ingredients was used, except for the oil seed additives. Considering the fact that linseed contains around 40% fat (Gambus et al., 2003), and hemp on average 35% fat (Callaway, 2004), the overall fat content should be increased by the addition of both ingredients. The only statistically significant difference was noted for the addition of both of them together. That might be caused by the mucilage from linseed, which helped to reduce fat outflow from the product. Despite the increase of the total fat content, in the product with hemp seed and linseed the fatty acid profile was positively changed (Table 5). The total polyunsaturated fatty acid content was higher than in the control product. Saturated and monounsaturated fatty acid content decreased and polyunsaturated fatty acid content increased in H and HL. The increase of n-6 fatty acids was the highest in the product with hemp, but was also very high in the one with linseed. The n-3 fatty acid content was almost 6 and 9 times higher respectively in H and HL, compared to the control product. The most significant change in the α-linolenic acid content was noted in HL pâté due to its high linseed content (~60% of the total fat; Gur et al., 2006). The relation of n-6 to n-3 fatty acids was also lowered in HL to the recommended value of 4:1 (Jarosz, 2012). According to the EU regulation 1924/2006, with 116/2010 amendment (EC, 2006), on nutrition and health claims made on food, the declaration of the n-3 fatty acid content can be made only on products containing at least 0.3 g of ALA per 100 g and per 100 kcal of a product. The product with both hemp seed and linseed contained 5.7% α-linolenic acid in the total fat content, which means that there was 1.04 g of ALA in 100 g and 0.4 g per 100 kcal of the pâté. It has been confirmed by various studies that high intake of n-3 fatty acids is associated with low chronic inflammation, which plays an important role in the onset of many diseases (Nabavi et al., 2015). The world's n-3 fatty acids intake is very low (Stark et al., 2016). Therefore, every dietary source of these fatty acids can be important. Hemp seed and linseed are cheap and readily available materials, so adding them to a product such as pâté should not increase the final price, which is the most important factor when considering the overall impact on public health. The most important aspects to be considered when introducing a product such as this onto the market are the product's price and taste (Shan et al., 2016).

The acceptability of products such as this to consumers has been confirmed in various studies. Beef pâtés in which the animal fat was replaced by an emulsion

Table 3. Color parameters of the pâtés

Variant	L^*(D65)	a^*(D65)	b^*(D65)
Control pâté (C)	55.92^{a} ±3.03	1.61^{a} ±0.56	14.92^{a} ±1.30
Pâté with hemp seed (H)	56.90^{a} ±1.83	1.72^{a} ±0.40	15.62^{a} ±1.01
Pâté with hemp seed and linseed (HL)	55.98^{a} ±3.14	1.93^{a} ±0.69	14.85^{a} ±1.58

^{a,b} Different letters in columns indicate significant differences between means ($P < 0.05$).

containing polyunsaturated fatty acids received scores which were slightly lower than control samples (Alejandre et al., 2017). In the studies by Valencia et al. (2008), the addition of linseed oil did not change the sensory scores for flavor, unlike products with fish oil, for which the flavor and general acceptability were evaluated less favorably. It may be necessary to encapsulate the oils which are added, as was suggested by Pelser et al. (2007). The panelists declared that the Dutch-style frankfurters with added flaxseed or fish oil resembled the control most. It was proved by Sampels et al. (2015) that consumers' perception of the modified products may depend on the type of product. There are also studies showing a positive effect on the general quality of the products when animal fat is replaced, but no sensory analysis was conducted (Dominguez et al., 2016; 2017). Consumers' scores (Fig. 1) for parameters such as taste, appearance and overall acceptability were higher for the products containing oil seeds than for the control product, although the differences were not statistically significant. The texture score of the pâté with hemp seed and linseed was significantly ($P < 0.05$) higher than the other two analyzed products. The impression of moisture was comparable in all of the analyzed products.

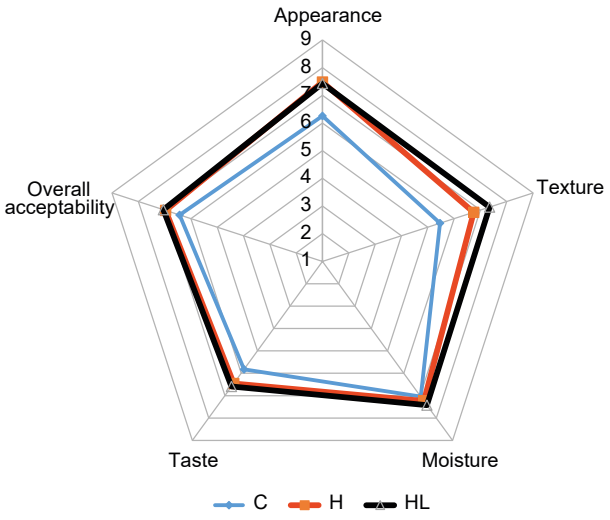

Fig. 1. Sensory analysis result

The instrumental color analysis (Table 3) did not show any significant differences between the products. Their lightness value was 56, redness was rather low, with an average a^* value of 1.8, and yellowness was much higher , with an average b^* value of around 15.

The texture parameters of the analyzed products are presented in Table 4. Oil seed additives significantly increased the hardness and chewiness of the pâtés. The adhesiveness was also significantly higher compared to the control product. The pâté with hemp was comparable to the product without oil additives in terms of cohesiveness, which was significantly higher for the product with hemp seed and linseed.

The pâté with both hemp seed and linseed was harder than the control product. Higher stock addition could increase production yields without decreasing product quality, which is important from the manufacturers' point of view. The texture of a modified product may vary depending on the type of modification (Dominguez et al., 2016; 2017). Delgado-Pando et al. (2011) declared that fat reduction did not change the texture parameters, while the addition of konjac gel made the products harder. The replacement of 50% of the animal fat by emulsified canola oil resulted in a softer and more spreadable texture, with lower lipid rancidity (Morales-Irigoyen et al., 2012). On the other hand, Youssef and Barbut (2011) declared that the addition of emulsified canola oil resulted in harder products.

Table 4. TPA parameters of the pâtés

Variant	Hardness [N]	Adhesiveness	Cohesiveness	Chewiness [N]	Resilience
Control pâté (C)	$3.04^{b} \pm 0.60$	$-147.57^{a} \pm 52.25$	$0.24^{b} \pm 0.03$	$0.25^{c} \pm 0.07$	$0.03^{a} \pm 0.01$
Pâté with hemp seed (H)	$4.19^{a} \pm 0.85$	$-254.14^{a} \pm 121.28$	$0.25^{b} \pm 0.03$	$0.42^{b} \pm 0.11$	$0.03^{a} \pm 0.01$
Pâté with hemp seed and linseed (HL)	$5.00^{a} \pm 1.04$	$-281.76^{b} \pm 126.80$	$0.29^{a} \pm 0.06$	$0.53^{a} \pm 0.07$	$0.04^{a} \pm 0.02$

[a,b] Different letters in columns indicate significant differences between means ($P < 0.05$).

Table 5. Fatty acid profile of the pâtés, %

Variant	Control pâté (C)		Pâté with hemp seed (H)		Pâté with hemp seed and linseed (HL)	
10:0	0.041[a]	±0.038	0.034[a]	±0.025	0.026[a]	±0.022
12:0	0.049[a]	±0.034	0.038[a]	±0.027	0.035[a]	±0.022
14:0	1.470[a]	±0.465	0.933[b]	±0.286	0.837[b]	±0.343
14:1	0.012[a]	±0.003	0.010[a]	±0.004	0.009[a]	±0.004
15:0	0.032[a]	±0.014	0.021[a]	±0.010	0.022[a]	±0.013
16:0	26.553[a]	±3.266	20.097[b]	±1.747	19.690[b]	±3.652
16:1n-9	1.059[a]	±0.437	0.941[a]	±0.431	0.929[a]	±0.412
16:1n-7	3.108[a]	±0.302	2.229[b]	±0.154	2.241[b]	±0.314
17:0	0.155[a]	±0.056	0.106[a]	±0.042	0.114[a]	±0.050
17:1	0.144[a]	±0.043	0.100[a]	±0.046	0.098[a]	±0.045
18:0	12.237[a]	±1.555	10.138[b]	±0.612	9.901[b]	±1.325
18:1n-9	39.425[a]	±1.377	33.773[b]	±0.937	34.275[b]	±0.564
18:1n-7	4.324[a]	±0.563	4.792[a]	±1.016	4.935[a]	±1.212
18:2n-6	9.534[b]	±2.498	21.672[a]	±2.303	19.580[a]	±2.500
18:3n-6	0.025[b]	±0.006	0.314[a]	±0.053	0.272[a]	±0.080
18:3n-3	0.509[c]	±0.210	3.530[b]	±0.839	5.736[a]	±2.262
CLA	0.012[b]	±0.006	0.022[b]	±0.008	0.035[a]	±0.019
20:0	0.104[b]	±0.025	0.244[a]	±0.056	0.253[a]	±0.060
20:1	0.452[a]	±0.061	0.368[b]	±0.076	0.389[ab]	±0.065
20:2	0.219[a]	±0.041	0.167[b]	±0.021	0.179[b]	±0.010
20:3n-6	0.038[a]	±0.012	0.030[a]	±0.005	0.030[a]	±0.009
20:4n-6	0.265[a]	±0.173	0.203[a]	±0.053	0.192[a]	±0.067
20:4n-3	0.044[a]	±0.008	0.033[b]	±0.008	0.039[ab]	±0.005
20:5n-3	0.034[a]	±0.018	0.051[ab]	±0.007	0.056[b]	±0.020
22:4n-6	0.048[a]	±0.026	0.050[a]	±0.013	0.040[a]	±0.006
22:5n-3	0.034[a]	±0.024	0.043[a]	±0.009	0.038[a]	±0.006
22:6n-3	0.035[a]	±0.013	0.025[b]	±0.006	0.022[b]	±0.001
SFA	42.666[a]	±2.886	30.720[b]	±1.961	32.804[b]	±4.067
MUFA	47.570[a]	±0.911	42.501[b]	±0.340	42.940[b]	±1.538
PUFA	9.729[a]	±2.113	26.686[a]	±1.587	24.193[a]	±2.723
n-6	8.925[b]	±1.948	23.212[b]	±1.386	19.061[c]	±1.498
n-3	0.562[b]	±0.137	3.347[a]	±0.530	4.962[a]	±1.264
n-6/n-3	16.091[a]	±0.526	7.169[b]	±0.958	4.088[c]	±0.727
PUFA/SFA	0.235[b]	±0.066	0.876[a]	±0.109	0.766[a]	±0.178

[a,b] Different letters in rows indicate significant differences between means ($P < 0.05$).

CONCLUSION

The results of the above-mentioned studies, and also that presented here, show that the production of healthy products is difficult because of the many aspects which must be taken into consideration. The pâtés with oil seeds in this study contained considerable amounts of ALA and a preferable n-6 to n-3 fatty acid ratio. They were also positively evaluated by the consumers, which demonstrates that it is possible to manufacture healthy and tasty meat products.

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