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Proceeding Paper

The Effect of Adding Degreased Flaxseeds on the Quality of Pates †

Anna Florowska *, Tomasz Florowski, Monika Krajewska and Adonis Hilal

Department of Food Technology and Assessment, Institute of Food Science, Warsaw University of Life Sciences-SGGW, 02-787 Warsaw, Poland; tomasz_florowski@sggw.edu.pl (T.F.); monikakrajewska93@o2.pl (M.K.); adonis_hilal@sggw.edu.pl (A.H.)

* Correspondence: anna_florowska@sggw.edu.pl

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Abstract: The aim of this research was to determine the effects of the addition of defatted flaxseeds (3.0%, 6.0%, 9.0%, 12.0%, and 15.0%) on the selected quality features of liver pates. The quality of pates was characterized on the basis of sensory assessment and pH, water activity, water-holding capacity, drip loss during refrigerated storage, color and texture parameters. Results of the analysis showed that degreased flaxseed addition at a level of 3% had no significant impact on most of the analyzed physico-chemical and sensory characteristics of the pate. It was found that a higher level (especially 12–15%) of flaxseeds reduced pates' sensory quality, mainly by increasing the intensity of the taste of the seeds. The largest tested addition of flaxseeds to the stuffing of pates resulted also in a change in color parameters by the seeds lowering the lightness (L*) and increasing the yellowness (higher +b* value), as well as increasing the penetration force and hardness and lowering the cohesiveness of the products. The positive effect of the addition of degreased flaxseeds, besides adding to the health value of pate, was also the improved water-holding capacity and reduced mass loss during refrigerated storage.

Keywords: degreased flaxseeds; pate; quality of product

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1. Introduction

Degreased flaxseeds are formed as a by-product after pressing flaxseed oil, most often utilized as animal feed [1]. However, it is an ingredient naturally rich in bioactive compounds such as protein (20–30%), fiber (about 30%), mucilage and lignan [2]. All those substances have positive health impacts, even in treating or preventing some diseases [3]. For example, lignan from flaxseed reduces blood glucose [4], mucilage improves gastrointestinal health [5], and proteins and peptides exhibit activities potentially beneficial for human health, such as fungistatic, antihypertensive, antioxidant, and anti-inflammatory activities, and prevent the occurrence of neurodegenerative diseases [6].

Currently, an increase in the interest and consumption of linseed oil has been observed, and with it the production of linseed oil, as well as the waste of this process, which are degreased flaxseeds [1]. For these reasons, degreased flaxseeds have started to also be an economically important ingredient, the use of which, in addition to being in line with the hugely popular zero-waste trend, increases the health value of the food.

At the moment, in research studies, degreased flaxseeds have been used in bakery and confectionery for the production of health promotion; also, they have been used in gluten-free products [7] as well as in the production of food for consumers on a vegan diet, mainly as milk and egg substitutes [8]. However, in the available scientific research, there is insufficient information on the potential use of such an ingredient in the production of meat products. However, based on the experience of other industries, it is known that it

is an ingredient that can have a strong impact on the quality of a final product, as it may change its physicochemical properties.

That is why the aim of this research was to determine the effect of the addition of defatted flaxseeds on quality pates. Six variants of baked pate were prepared, i.e., the control sample (without degreased flaxseeds) and five samples with the addition of different quantities of degreased flaxseeds: 3.0%, 6.0%, 9.0%, 12.0%, and 15.0%. The quality of the pates was characterized on the basis of their sensory assessment and pH, water activity, water-holding capacity, drip loss during refrigerated storage, color parameters and texture parameters.

2. Materials and Methods

2.1. Materials

Degreased flaxseeds (SANTE, Warsaw, Poland): protein 34 g/100 g, fiber 32 g/100 g, and fat 12 g/100 g.

Meat raw materials: pork shoulder, jowl, liver (SOKOŁÓW SA, Sokołów Podlaski, Poland), skin emulsion (ZYCHOWICZ, Daleszyce, Poland), and egg mass (local supplier).

Spices: salt, marjoram, herbal pepper, black pepper, onion, and nutmeg (local supplier).

2.2. Pate Preparation

In the production of the pates, the meat and jowl were first cooked for 1.5 h and 40 min, respectively. Then, the meat and jowl were ground in a laboratory grinder with a mesh diameter of 4.5 mm. The pork liver was homogenized with salt (2%). The pate batter was created in Stephan's cutter by mixing ingredients (pork shoulder 32%, hot broth 28%, jowl 20%, skin emulsion 6%, pork liver 6%, egg 4%, onion (fried) 2%, salt 1.2%, herbal pepper 0.2%, marjoram 0.2%, black pepper 0.1%, and nutmeg 0.05%) and the degreased flaxseed in the tested amounts was added. The batter was homogenized for 4 min, and the finished batter was put into molds and baked in two stages. They were first steamed at 90 °C and then baked at 180 °C until reaching a thermal central temperature of 72 °C. After heat treatment, the pates were cooled and stored in a cold room for 24 h. Liver-pate production was performed in five repetitions (n = 5).

2.3. Methods

2.3.1. Sensory Quality

The pates were subjected to sensory evaluation using the QDA method after 24 h from production. The evaluated distinguishing features were their odor, hardness and juiciness, taste and general desirability. The respondents marked the evaluation results on a 10 cm graphical scale.

2.3.2. pH

The pH was measured in an aqueous solution (10% pate) using a CP-401 pH-meter (ELMETRON) and a combined electrode OSH 12-00 (ELMETRON, Zabrze, Poland).

2.3.3. Water Activity

The AQUA LAB device was used to measure water activity. The measurement temperature was 23 °C.

2.3.4. Water-Holding Capacity

The 300 mg sample of the ground pate was placed between glass plates on filter paper previously conditioned with a saturated KCl solution, and loaded with a 2 kg weight for 5 min. Then, using the ImageJ computer program, the leakage boundary and the area occupied by the pate were outlined. The amount of leakage was determined on the basis of the difference in the area occupied by the leakage separated from the product and the pressed product. The result was expressed in cm^2 per gram of product.

2.3.5. Drip Loss during Refrigerated Storage

The samples (sliced to a thickness of 5 cm) for the test were vacuum-packed and stored for three weeks in refrigeration conditions (4–6 °C). The amount of leakage was determined based on the difference in the weight of the sample before and after cold storage. The result was expressed as a percentage.

2.3.6. Color Parameters

The color parameters of the pates were measured using the reflection method using a Minolta CR-200 colorimeter (Konica Minolta, Warszawa, Poland) by measuring the L*, a*, and b* color components. The measurement of color was made on a cross-section of the pates.

2.3.7. Texture Parameters

The texture of the pates (penetration force, hardness and cohesiveness) was analyzed using a TA. XT PLUS Texture Analyzer. Samples for the penetration force test were cut in the form of a 20 mm thick slice. The penetration force was measured by inserting a flat cut pin with a diameter of 10 mm into a pate sample. The maximum force needed to penetrate the pin to a depth of 10 mm was measured. The speed of the measuring head was 5 mm/s. The samples for the TPA test (parameters obtained: hardness and cohesiveness) were 20 mm cubes. The pate sample was compressed with a metal cylinder with a diameter of 50 mm while maintaining the following parameters: 25% deformation of the initial height; 5 s relaxation time between pressure measurements. The speed of the measuring head was 5 mm/s.

2.3.8. Statistical Analysis

The obtained results were statistically analyzed using the Statgraphics Plus 4.1 program. In order to determine the effect of the addition of degreased flaxseeds on the individual parameters of the quality of the baked pates, a one-way analysis of variance (ANNOVA) and detailed testing using the Tukey test were carried out; the assumed significance level was $\alpha = 0.05$.

3. Results and Discussion

To investigate the effect of adding degreased flaxseeds to pates, a sensory analysis was performed. On the basis of the sensory analysis, it was found that the addition of degreased flaxseeds in the amount of over 6% had a significant effect on the intensity of the meat and flaxseed odor and its taste in pates. It caused, in comparison to the control sample (without flaxseed), a decrease in the perceptibility of the odor and taste of the meat and an increase in the perceptibility of the odor and the taste characteristic to the linen (Figure 1).

What is more, the addition of degreased flaxseeds also affected the sensory-assessed hardness and juiciness. The addition of degreased flaxseeds to the pate batters in the amount above 9% resulted in a significant increase in the hardness of the evaluated products. On the other hand, the juiciness was influenced by the 6% addition of flaxseeds, causing a significant reduction. These changes also had an impact on the overall desirability of the products. It was found that the pates with the addition of 12 and 15% of degreased flaxseed obtained significantly lower desirability scores than the control pates (control pate: 6.5 ± 0.3; pate with the addition of 12%: 4.0 ± 1.4; pate with the addition of 15%: 2.8 ± 1.1). No such statistically significant differences were found at lower levels of degreased-flaxseed addition. Florowski et al. [9] drew similar conclusions when examining the effect of adding flaxseeds on the quality of restructured beef steaks. The authors found that the addition of 10% flax seeds resulted in a decrease in the overall quality of the products. The influence of the addition of flaxseeds on the sensory quality of meat products was also found by Yogesh et al. (2015) [10], who found changes in tested sensory characteristics with just a 2.5% addition of flax into the model meat product. The authors found that even such small

amounts of flaxseeds may cause unfavorable changes in taste in the opinion of consumers; however, in the tested pates, the addition of 3% flaxseeds was acceptable by the evaluators.

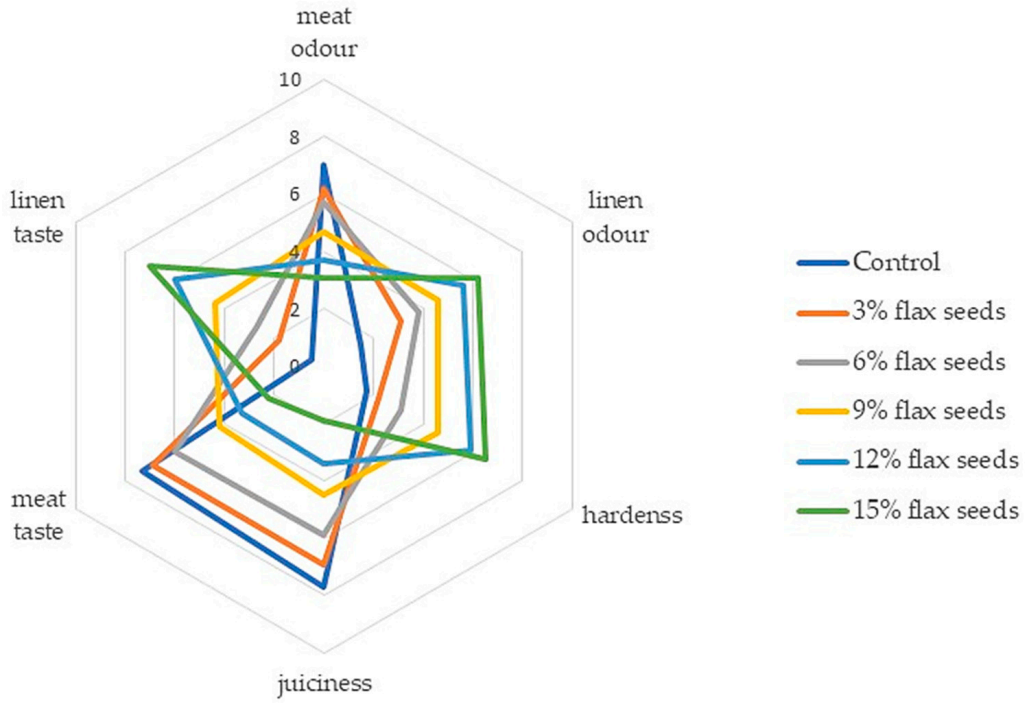

Figure 1. Effect of the addition of degreased flaxseeds on sensory quality features of pates.

Based on the results of the physicochemical analysis, it was found that the addition of flaxseeds had no effect on the pH or water activity of the tested pates. This effect was also found by Florowski et al. [9] when adding ground flax seeds into restructured beef steaks. However, its impact on the water-holding capacity and drip loss during refrigerated storage was found. The addition of degreased flaxseeds in amounts of 6% and more to the batter caused a significant improvement in the water-holding capacity of the product and the drip loss during refrigerated storage (Table 1). The ability to affect the water binding of flaxseeds in the product is due to the presence of, among others, gelling mucilages [11] and protein [12].

Table 1. Effect of the addition of defatted flaxseeds on physicochemical parameters of pates.

Variant	pH	Water Activity	Water-Holding Capacity [cm^2/g]	Drip Loss during Refrigerated Storage * [%]
Control	6.25 ± 0.06	0.970 ± 0.005	5.06 ^{d} ± 2.32	1.03 ^{c} ± 0.32
3% flaxseeds	6.24 ± 0.08	0.969 ± 0.004	3.73 ^{cd} ± 1.76	0.91 ^{bc} ± 0.18
6% flaxseeds	6.24 ± 0.08	0.969 ± 0.004	2.92 ^{bc} ± 0.98	0.75 ^{ab} ± 0.21
9% flaxseeds	6.21 ± 0.06	0.972 ± 0.005	1.61 ^{ab} ± 0.87	0.78 ^{ab} ± 0.21
12% flaxseeds	6.20 ± 0.04	0.968 ± 0.005	0.93 ^{a} ± 1.17	0.64 ^{ab} ± 0.17
15% flaxseeds	6.18 ± 0.04	0.967 ± 0.004	0.49 ^{a} ± 0.92	0.61 ^{a} ± 0.16

Means in columns with different letter symbols differ significantly ($p < 0.05$); * after 3 weeks of refrigerated storage of pates packed in vacuum.

Based on the conducted research investigating the effect of the addition of degreased linseeds on the color of pates, it was found that the introduction of a larger amount of flaxseeds into the batter resulted in a decrease in the L* color parameter (brightness) of the pates (Table 2). Statistically significant differences, in comparison with the control pate, were found for pates with the 12% addition of degreased flaxseeds. It was also found that

the addition of defatted flaxseeds had no significant effect on the values of the a* color parameter of the pates, but increased the value of the b* color parameter. Such an effect was observed with the lowest tested (3%) addition of seeds. The effect of the addition of flaxseed on the color of the products has been described in the literature, with indications of a statistically significant decrease in color brightness, which reflects the darker and brownish color of the flaxseed itself [1,13].

Table 2. Effect of the addition of defatted flaxseeds on color parameters of pates.

Variant	L*	a*	b*
Control	64.17 ^{c} ± 0.62	5.01 ± 0.49	10.69 ^{d} ± 0.75
3% flaxseeds	64.31 ^{c} ± 0.56	4.83 ± 0.61	11.85 ^{c} ± 0.18
6% flaxseeds	63.48 ^{bc} ± 0.54	4.46 ± 0.39	12.47 ^{bc} ± 0.59
9% flaxseeds	62.93 ^{bc} ± 0.83	4.66 ± 0.19	13.09 ^{ab} ± 0.26
12% flaxseeds	62.44 ^{ab} ± 0.90	4.78 ± 0.30	13.75 ^{a} ± 0.86
15% flaxseeds	61.43 ^{a} ± 0.87	5.04 ± 0.59	14.06 ^{a} ± 1.08

Means in columns with different letter symbols differ significantly ($p < 0.05$).

In some studies, however, the authors indicated the opposite effect, which was that flaxseed enrichment lightened the crust of the bread. The reason for this might be connected to a decrease in the availability of reducing sugars and free amino acids for the formation of Maillard reaction products, precursors to crust browning [13].

On the basis of the test's texture parameters, it was found that the introduction of a small amount of defatted flaxseeds, i.e., 3%, into the pate batter had no significant effect on any of the analyzed texture parameters (Table 3). With the addition of a larger amount of defatted flaxseeds, significant differences in the texture of pates were found compared to the control variant of the pate, including an increase in their penetration power (with the addition of 15% of defatted flaxseeds) and hardness (with the addition of 15% of defatted flaxseeds) and a decrease in their cohesiveness (with the addition of 6% defatted flaxseeds and more). The increased hardness of pates with the addition of flaxseeds is caused by the presence of fiber and protein, which significantly affect the structure of the products [14].

Table 3. Effect of the addition of defatted linseeds on the texture parameters of pates.

Variant	Penetration Force [N]	Hardness [N]	Cohesiveness
Control	3.48 ^{bc} ± 0.29	5.67 ^{a} ± 0.49	0.64 ^{a} ± 0.03
3% flaxseeds	3.00 ^{cd} ± 0.25	4.97 ^{a} ± 0.10	0.59 ^{ab} ± 0.04
6% flaxseeds	2.85 ^{d} ± 0.28	4.73 ^{a} ± 0.77	0.53 ^{b} ± 0.04
9% flaxseeds	3.00 ^{cd} ± 0.23	5.27 ^{a} ± 0.59	0.54 ^{b} ± 0.05
12% flaxseeds	3.56 ^{b} ± 0.20	5.68 ^{a} ± 0.36	0.55 ^{b} ± 0.03
15% flaxseeds	4.21 ^{a} ± 0.38	7.15 ^{b} ± 0.88	0.56 ^{b} ± 0.03

Means in columns with different letter symbols differ significantly ($p < 0.05$).

4. Conclusions

The results of the analysis showed that degreased-flaxseed addition at a level of 3% had no significant impacts on most of the analyzed physico-chemical and sensory characteristics of the pate. It is, therefore, possible to produce good-quality pates with 3% of this nutritionally valuable ingredient. The main limitation in introducing higher levels (especially 12–15%) of flaxseeds into the products is the deterioration of their sensory qualities, mainly, a decrease in the intensity of the taste and smell of the meat, along with an increase in the intensity of the taste of the seeds. The largest tested addition of flaxseeds to the stuffing of the pates also resulted in a change in their color parameters by lowering their lightness (L*) and increasing their yellowness (higher +b* value), as well as increasing the penetration force and hardness and lowering the cohesiveness of the products. The production of pates containing a higher amount of defatted flaxseeds

requires taking measures to minimize the adverse impacts of their addition on the quality of products. The positive effect of the addition of degreased flaxseeds, besides adding to the health value of pate, was also the improved water-holding capacity and reduced mass loss during refrigerated storage.

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