FATTY ACID CONCEN TRATION OF FISH OIL COMPARED WITH FRESH SPUN PASTE CHEESE ENRICHED IN ESSENTIAL FATTY ACIDS

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Abstract

In this study, it is desired to obtain a spun paste cheese enriched in essential fatty acids which come from tuna liver oil. They are produced by hand from sheep's milk to which fish oil is added. Fat is found in milk in the form of globules protected by an elastic lipo-protein membrane. To embed the fish oil inside the lactic fat globule, the mixture of milk and fish oil is pressurized to 200 bar at a temperature of 70^{0}C. In this way, the fat globules are split, but they are later restored and include the oil from the fish that adheres to the lactic fat.

Three essential fatty acids from cheese samples and fish oil were determined for analysis. They are found both in the fat in sheep's milk and in the fat in fish oil.

Three cheese samples were produced for the analysis: one sample without the addition of fish oil and two samples with the progressive addition of fish oil in proportions of 0.05% and 0.15%. The following results were obtained for cheese in the three samples according to the concentration of fish oil in the raw material sheep's milk: for linoleic acid (ω6) the proportions of 2.53%, 2.83% and 2.93% were determined, for linolenic acid (ω3) 0.89%, 1.08% and 1.15% and for acid γ -linolenic (ω6) 0.87%, 0.91% and 1.05%. For the fish oil used, the proportion of the three essential fatty acids analyzed was: linoleic acid 3.35%, linolenic acid 9.20% and γ-Linolenic acid 2.18%. All concentrations are reported as % fatty acids.

Keywords: fresh spun paste cheese fish oil

INTRODUCTION

Spun paste cheeses are dairy products rich in protein but also have a long preservation period.

Spun paste cheese is a product known and accepted by the population. It is an ecological and healthy product. Intention to purchase the product is increasing.

The price ratio, nutritional quality and safety of ecological products determine an increase in the intention to buy and consume these products (Morna Anamaria, 2021).

Sheep's milk is frequently used in the manufacture of cheeses.

Sheep milk subjected to refrigerated storage at 4 °C for 6 days and frozen at -29.8 °C for 90 days maintains its physicochemical and microbiological quality without measurable impact on protein fractions. However, refrigerated storage for 10 days affects pH, acidity with an increase in mesophilic and psychrotrophic bacteria leading to protein degradation (Danielle Specht Malta et al, 2021).

Cheese made with sheep's milk had a similar chemical composition and contained higher levels of low molecular weight saturated fatty acids (less than 10 carbon atoms), polyunsaturated fatty acids relative to total fatty acids than those made with milk of cow In addition, cheeses made from sheep's milk have superior sensory qualities than those made from cow's milk. Therefore, sheep cheeses could be considered suitable alternatives to cheeses made from cow's milk (Angélica A. Ochoa-Flores et al, 2021).

The use of whey from sheep's milk for the manufacture of fermented dairy products is possible. By adding 25%, resulted a product similar to that obtained from 100% milk. In addition 70% whey was observed good stability of products containing and was accepted by consumers. A good water binding capacity is obtained and and serum elimination is avoided. In contrast, dairy products made with 85% whey were unstable and sensory penalized in all characteristics evaluated (Alline Artigiani Lima Tribst et al, 2020)..

Although alternative protein sources offer numerous advantages over conventional dairy proteins, there are several disadvantages to fully incorporating them into cheese products. It also affects sensory qualities (Martha L. et al, 2023).

An increasing number of cheese companies are now using high protein milk (4–5%) to increase cheese yield. Previous studies have suggested that cheeses made from milk with high protein content (both casein and whey protein) may ripen more slowly. One explanation could be inhibition of residual clot activity due to high levels of whey proteins. Thus, it was likely that the higher residual whey protein content in the cheese inhibited proteolysis during ripening, and the lower denaturation rate resulted in higher hardness and melting point in the cheese. This provides the benefit of controlled ripening rates (E. Reale et al, 2022).

Transglutaminase (TG), glucono-δ-lactone (GDL) and citric acid (CA) were used with milk fat emulsion gelling and whey protein isolate (WPI) to incorporate lutein and form gel emulsion which were used to make the cheese. The protective effect of emulsion gels induced in different ways on lutein was investigated and the stability of lutein in emulsion gels and processed cheese was analyzed. They offer the possibility of applying emulsion to the gel that includes active substances in the processed cheese (Hongjuan Li. Et al, 2023).

Emulsion and emulsion gel obtained by pre-emulsification of butter with whey protein isolate (WPI) have been applied in cheese making. Processed cheese was sterilized at 121 °C or pasteurized at 100 °C for 15 min, then stored at 25 °C or 4 °C. The effects of pre-emulsification and pasteurization on the texture, functional characteristics and Maillard reaction of processed cheese during storage were investigated. The pre-emulsification process slowed the Maillard reaction of cheese stored under refrigeration and reduced the content of Maillard reaction products and eliminated textural defects in cheese stored at room temperature (Hongjuan Li. Et al, 2023).

Pressure membrane separation processes have been integrated as unit operations in cheese making for decades. Concentrated systems obtained by membrane separation processes are currently used in cheese milk for standardization, milk protein enrichment, micellar casein. Eco-efficiency is an important aspect of cheese production, improving cheese yield and profitability while reducing the influence of cheese factories on the environment. Simulation and optimization studies have been published showing the potential of pressure-based separation processes to improve eco-efficiency. In parallel, the spectacular evolution of near-infrared spectroscopy allowed the normalization of the composition of milk for cheese, and with the advanced knowledge of cheesemaking and the development of innovative automatic adjustment tools, precision cheesemaking is now possible. The next step will involve automatic tuning tools in process control, which will further improve the performance of the cheese factory (Julien Chamberland et al, 2022).

In addition to proteins, the fatty substance in the composition of milk is an important factor that determines the nutritional and biological value of cheeses.

Milk fat is cholesteremic, which has led to the enrichment of dairy products by adding fish oil, which is rich in mono- and polyunsaturated fatty acids.

(Fish oils are good sources of omega-3 and omega-6 polyunsaturated fatty acids (ω-3 and ω-6 PUFA) with beneficial effects on human health. Therefore, fish oils could be considered as functional oils, for use in food, cosmetic and pharmaceutical products (Abdul Rohman et al, 2021).

Hypertriglyceridemia is a type of dyslipidemia characterized by high levels of triglycerides in the blood and increases the risk of cardiovascular disease. Conventional management includes antilipidemic drugs such as statins, lowering LDL and triglyceride levels, as well as increasing HDL levels. Studies have shown that fish oil supplements reduce the risk of cardiovascular disease (Muhammed Ibrahim Erbay et al, 2023).

Microalgae oils have been shown to contain enough omega-3 LC-PUFA to serve as an alternative to fish oil, which has been used as the "gold standard". C In microalgae oils, an important part of long-chain omega-3 polyunsaturated fatty acids are present in the polar lipid fraction, which may be favorable in terms of bioavailability and stability. The consumption of microalgae oil ensures the intake of sterols and carotenoids. Sterol intake, including cholesterol and phytosterols, is probably not relevant. The carotenoid intake is however certainly significant and could give microalgae oils an added nutritional value compared to fish oil (Eline Ryckebosch et al, 2004).

Much attention has been paid to the safety and quality of aquatic products, including the consumption of Chinese crab (Eriocheir sinensis), which provides both nutritional benefits and decreases toxicological risks. Eighteen sulfonamides, 9 quinolones, and 37 fatty acids were analyzed in 92 crab samples from primary aquaculture provinces in China. The risk-benefit ratio (HQ) between the adverse effects of antimicrobials and the nutritional benefits of EFA in crabs found that there was less risk of antimicrobials from consuming crab with low risk to human health (Chao Song et al, 2023)..

Dietary n-3 PUFA supplementation has many benefits for patients with type 2 diabetes, primarily in improving dyslipidemia, especially hypertriglyceridemia. The effects of n-3 PUFA on glucose control, blood pressure, inflammation, and oxidation are less established. While high-dose n-3 PUFA supplementation in diabetic subjects can lower blood sugar, moderate intake of n-3 PUFA has no adverse effects on insulin resistance and may in fact reduce several risk factors for people with the disease of diabetes (Iwona Rudkowska et al, 2010).

MATERIAL AND METHOD

In this study, fresh sheep's milk spun paste cheese with an increased content of essential fatty acids was manufactured. Sheep milk was harvested from Bihor county in April, during the first lactation period. To enrich the spun paste cheese in essential fatty a the protein percentage was analyzed by the Kjeldal method cids, fish oil was added to the milk. 3 samples were performed with increasing additions of 0%; 0.05% and 0.15% fish oil. In order for the fish oil to be embedded in the globule of the milk fat molecule, the mixture of milk and fish oil was homogenized at temperatures of 70 ^{0}C and pressure of 200 Bar.

In the homogenization process, the membrane of the fat globule splits and the fish oil adheres to the milk fat. Afterwards, the membrane of the fat globule is restored, using the protein substance from the composition of milk, and the fish oil, rich in essential fatty acids, is embedded inside the globule.

The sheep's milk was analyzed from a sensory point of view, but no defects were detected in the color, appearance, consistency, taste and aroma of the milk. From a physico-chemical physico-chemical point of view, the acidity, fat percentage, density, protein and lactose concentration of raw milk were determined.

- Acidity: acidity was determined both by the titratable method and by the boiling test. The analysis of the acidity through its heat treatment is mandatory because it also checks the possible thermal precipitation of the protein that can block the Lacto-star analysis device as well as the devices used in the manufacturing process;
- The percentage of fat was determined by the acid-butyrometric method;
- The density of milk was determined by the areometric method.

The chemical composition of raw milk was analyzed with the LACTO-STAR device.

The cheese samples were analyzed from a sensory point of view by 5 unauthorized persons.

From a physico-chemical point of view, it was determined:

- acidity, the titratable method was used;
- total dry matter, by the oven drying method;
- the percentage of fat by the acidobutyrometric method. The fat was related to the total dry matter;
- the protein percentage was analyzed by the Kjeldal method.

Fatty acids in the composition of milk, cheese samples and fish oil were analyzed by gas chromatography.

For the analysis of fish oil incorporation in cheese samples, three essential fatty acids that are specific to both sheep's milk and fish oil were considered.

Linoleic acid (ω6), linolenic acid (ω3), and γlinolenic acid (ω3) were analyzed statistically.

RESULTS AND DISCUSSIONS

Through the sensory analysis of the samples, a fishy taste and aroma was noticed in the 0.15% samples, which disappeared after 4-5 days. In the other samples, the specific taste and aroma of fish was not present.

The coding of samples is presented in

table no. 1

Table 1.

The coding of spun paste cheese samples from sheep's milk enriched in essential fatty acids

No	Added fish oil %	sample code	
		fresh spun paste cheese	fish oil
1	0	C_{p0}	FO
2	0,05	$C_{p0,05}$	FO
3	0,15	$C_{p0,15}$	FO

From a sensory point of view, the cheese samples were evaluated by 5 unauthorized persons There were no differences in terms of the appearance of the paste or the color. A The fish taste was noticed in the cheese with the addition of 0.15 fish oil, but it disappeared after 5 days. This inconvenience can be removed by deodorizing the milk.

Physico-chemical analyzes demonstrated that there are no essential differences between the samples with and without the addition of fish oil. Gas chromatography determined 19 fatty acids from the cheese samples. Fatty acids from the used cod liver oil were also analyzed. Three essential fatty acids specific to both fish oil and sheep's milk cheese with added fish oil were considered: linoleic acid (ω6), linolenic acid (ω3) and γlinolenic acid (ω6). Essential fatty acids were reported to total fatty acids.

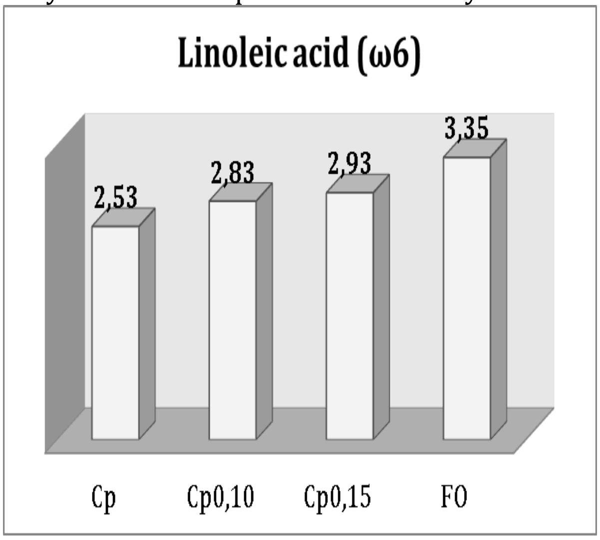

Figure 1 Concentration of linoleic acid (ω6)in fresh spun paste cheese samples compared to fish oil% of total fatty acids

Linoleic acid from fish oil is found in fresh cheese samples at a rate of 9% in the Cp0.05 sample, and 12% in the Cp0.15 sample compared to the Cp0 sample without added fish oil (figure 1).

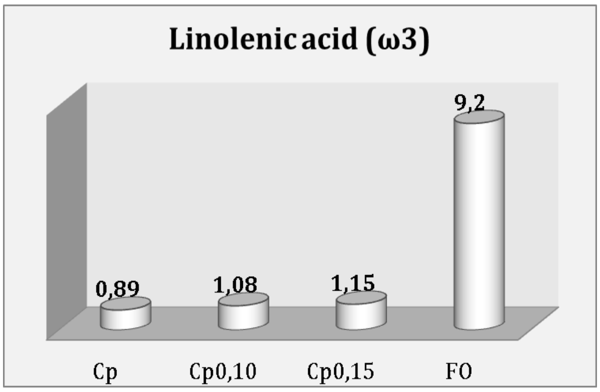

Figure 2 **Concentration of linolenic acid (ω3) in fresh teleme cheese samples compared to fish oil % of total fatty acids**

Linolenic acid is in the proportion of: 2% in the Cp0.05 sample and in the proportion of 3% in the Cp0.15 sample compared to the control sample, without the addition of fish oil (figure 2).

The γlinolenic acid from fish oil is found in the fresh cheese samples in the following proportions compared to the Cp0 sample: 3% in the Cp0.05 sample; and 8% in the Cp0.15 fish sample (figures 3).

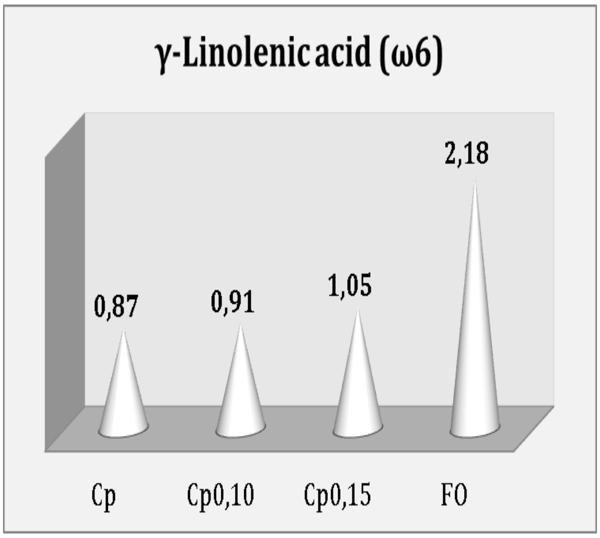

Figure 3 **Concentration of γlinolenic acid (ω6) in fresh spun paste cheese samples compared to fish oil % of total fatty acids**

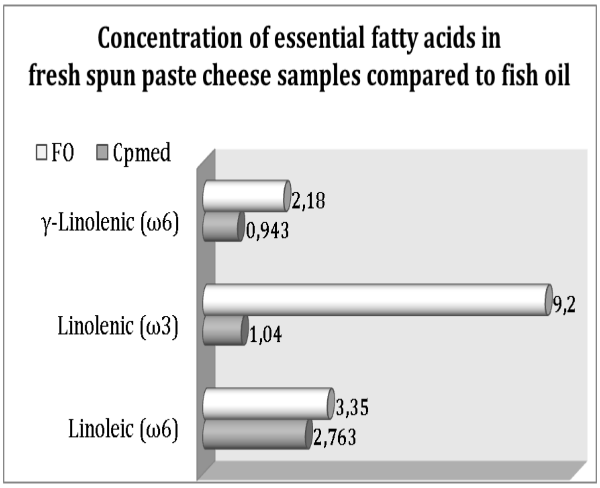

Figure 4 Concentration of essential fatty acids in fresh spun paste cheese samples compared to fish oil % of total fatty acids

If we take into account the average of the essential fatty acids in cheese curds compared to that in fish oil, it is found that linoleic acid is 82%, linolenic acid 11% and γ-linolenic acid 43%.

So linoleic acid is incorporated the most, followed by γlinolenic acid (ω6), and linolenic acid (ω3) the least.

Figure 5 shows that the chromatograms of the studied essential fatty acids falling between those of the samples with 0 addition of fish oil and fish oil.

This demonstrates that the lactic fat globule has incorporated the essential fatty acids from the fish oil in varying proportions.

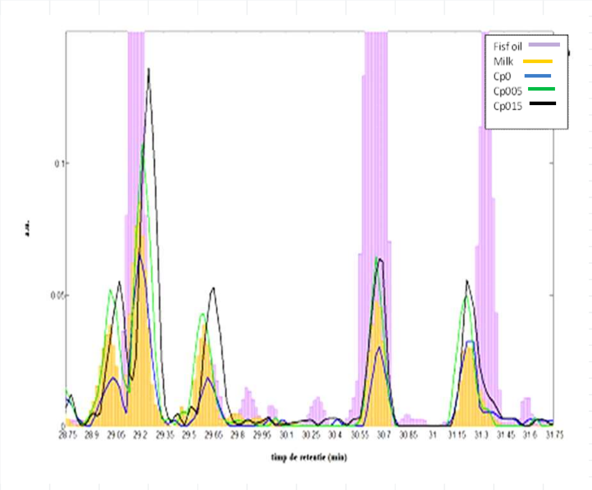

Figure 5 Graph of superimposed chromatograms of fresh spun paste cheese samples with and without addition and fish oil - the detection zone of the studied essential fatty acids

CONCLUSIONS

Sensory characteristics of the cheese with the addition of fish oil in the raw material milk do not differ in terms of the color and appearance of the paste compared to the one without the addition of fish oil.

The taste is affected in the samples with the highest addition, but the fishy taste disappears in 4-5 days.

The physico-chemical characteristics do not show significant differences.

The three analyzed essential fatty acids that are enriched by the addition of fish oil in raw sheep's milk are found in fresh spun paste cheese samples.

Linoleic and γlinolenic ω6 fatty acids are found in the highest proportion, followed by the proportion of linolenic acid (ω3).

The fishy taste and aroma could be removed by removing the fishy taste and aroma by deodorizing the milk with the addition of fish oil at 70^{0}C under vacuum.

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