ESSENTIAL FATTY ACID CONCENTRATION OF FISH OIL COMPARED WITH FRESH TELEME CHEESE ENRICHED IN ESSENTIAL FATTY ACIDS

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Abstract

This article proposes the enrichment of a dairy product in essential fatty acids by adding fish oil to the raw material sheep's milk. In order for the product to be assimilated as easily as possible in the human organism, an attempt is made to incorporate the fish oil into the milk fat globule. Teleme cheese is a product accepted by Romanian consumers and frequently consumed. That is why it was chosen to obtain and analyze fresh telemea cheese enriched in fatty acids. 19 fatty acids from raw milk, fish oil and finished product were analyzed by gas chromatography.

Three cheese samples were manufactured with different concentrations of fish oil added to raw material milk: 0.05%; 0.10% and 0.15%.

Three representative fatty acids for sheep's milk and fish oil were analyzed and the following results were obtained: linoleic acid in a proportion of 3.35% in fish oil and in the three cheese samples an average of 3.018 was obtained. therefore the fish oil was embedded in the fat of the cheese to the extent of 90%. All values were reported on 100% fatty acids.

Keywords: fresh teleme fish oil

INTRODUCTION

Cheeses are dairy products very widespread and accepted by the population. By making them, the shelf life of milk increases and the storage space is reduced. Thus they can be produced in the summer, when the i quantity of milk is higher, and consumed in the winter. They can also be transported more easily.

Telemea cheese is a well-known Romanian product and that is why the population has quite a lot of confidence that it is an ecological and healthy product. The correlation between the price and safety of organic products and the intention to buy and consume is good (Morna Anamaria, 2021).

Telemea cheese is a cheese that matures in brine with a concentration of 30% whey without albumin and acidified with a culture of selected lactic bacteria.

Ripening in a brine solution is a preservation method used especially in countries with warm climates, which mainly include Mediterranean, Balkan and Middle Eastern countries and some Latin American countries. The microflora of cheeses matured in brine is different from that of other cheeses and significantly influences their biochemical characteristics and volatile composition. A certain (not extensive) level of proteolysis and lipolysis is observed in this cheese variety, due to the higher salt level and lower pH, this the latter favoring retention of the coagulant in the curd during draining.

The brine immersion method for salting these cheeses is different from other salting methods (for example, dry salt, curd salt and pieces of cheese smaller than 500 g)). Thus the cheeses are matured and preserved in brine until consumption. Due to the smaller size compared to other cheeses, the salt in the brine diffuses into the piece of cheese and increases the salt concentration. Thus, some biochemical transformations are limited and others are favored that determine the formation of the specific flavor cheese in the brine. Therefore, the resulting taste or flavor in brine cheese is different from that of other cheeses and is unique to these cheese varieties (Ali TekinAli et al, 2022).

Cheeses are dairy products concentrated in milk protein, which determines their high nutritional value. Cow's milk protein is one of the main food allergens. It has been shown that by fermentation with lactic acid bacteria of the genus Lactobacillus Helveticus and Lactobacillus Plantarum, a combination of both strains, a hydrolysis of α-casein and β-lactoglobulin is obtained by the proteases of the bacterial strains (Lina Zhao et al, 2021).

Milk proteins are considered valuable biopolymers with adequate thermal stability, non-toxicity, preventing loss of humidity and flavors, protective against gases. These qualities could allow their use in obtaining milk protein-based packaging as promising alternatives to petroleum-based polymers. The disadvantages would be sensitivity to, fragility, humidity low elasticity. However, selection of the correct source of milk proteins in addition to suitable fortifiers and procedures based on the nature of the food could guarantee a well-protected food with an extended shelf life and the lowest environmental impact (Farhad Garavand, et al, 2022).

Various treatments applied during milk processing affect milk proteins. In the manufacture of cheeses from milk pasteurized at 85 °C, many new peptides, not detected in raw cow's milk and lost in the whey, were revealed. Therefore, pasteurization favors proteolysis. Also, during the ripening of the cheeses, the partial denaturation of the proteins takes place. These biochemical transformations favor the digestion of proteins in the body (Marco Franzoi, et al, 2022).

During storage at refrigeration temperature (0-60 days) at 4-8 °C it has been shown that both the consistency of the cheese and its composition are affected. Therefore the cheese becomes more crumbly but the syneresis decreases. Also, partial protein denaturation occurs and the results of microstructure analysis showed that traces of whey disappeared while the proteins were hydrated and free water was removed from the cheese. Also, the fat globules were deformed during refrigeration. In conclusion, changes in cheese structure during refrigerated storage occurred under the effects of protein proteolysis and hydration, as well as dissolution of bound calcium (Mengyuan Guo, et al, 2022).

The fat in the composition of milk plays an important role both in human nutrition and in the manufacturing process of dairy products and cheeses. Animal feed influences the composition of milk. Thus, in the case of sheep's milk, the diet rich in olive oil caused an increase in the fat content of the manufactured cheese and resulted in a lower percentage of saturated fatty acids and the total of monounsaturated and polyunsaturated fatty acids increased in percentage. Also, the obtained cheese presented a higher antioxidant capacity (Viviana Bolletta et al, 2022).

Milk is a product rich in fat-soluble vitamins with an important role for the human body. Vitamin K is vital for normal blood clotting and can influence bone, neurological and vascular health. This vitamin was found in cheeses but also in lamb and chicken meat (Eleanor Dunlop et al, 2022).

It is specific to milk from small animals (sheep and goats) its content in small molecule fatty acids, but they also have an increased content in essential fatty acids. The body's resistance to heat stress is favored by essential fatty acids (Lei Zhou et al, 2021).

Dietary fatty acid intake can play a major role in the prevention and management of lifestyle diseases such as type 2 diabetes (T2DM). Ratios of ω-6 to ω-3 fatty acids may serve as critical predictive biomarkers in the management of patients with type 2 diabetes. This would not only help in management but also help in preventing the increase in incidence of T2DM. These theories impose the need to maintain an ideal balance between ω-6 and ω-3 because prevention is always better than cure (Shilpa S. Shetty et al 2021).

The pandemic disease of (coronavirus disease 2019) COVID-19 caused by SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2) can be fatal due to damage to pulmonary vascular endothelial cells and other vessels (endotheliopathy), alveolar exudative inflammation and interstitial inflammation , alveolar epithelial proliferation and hyaline membrane formation leading to acute respiratory failure. COVID-19 is associated with excess production of the pro-inflammatory cytokine tumor necrosis factor-α and possibly other cytokines. COVID-19 affects almost all vital organs in the body. A diet high in unsaturated fat, moderate in protein and low in carbohydrates results in the production of ketones, which are used as fuel by the body and thus leads to a faster metabolism, decreased hunger and a decrease in more effective weight. This diet was originally recommended for children with epilepsy, although why it is effective is not clear. It is beneficial for those with type 2 diabetes, high blood pressure and obesity. Diet high in unsaturated fat enhances interferon production that is mediated by increased lactate production and thus suppresses the "cytokine storm" seen in COVID-19 (Undurti N. Da, 2020).

Fish oil is a product rich in essential fatty acids beneficial for the body. 154 / 5.000

Cardiometabolic multimorbidity (CMM) has become a global public health problem with increasing prevalence and a more severe clinical prognosis The association between fish oil use and mortality among patients with CMM was based on a study on. 30,068 UK Biobank participants (67.9% men with an average age of 61.75 years). 5,357 deaths were reported during 12 years of follow-up. For patients with CMM, fish oil use was associated with a 17% lower risk of all-cause mortality and a 19% lower risk of cardiovascular mortality. At age 45, fish oil use was associated with 1.66 years of life expectancy gained. So, among CMM patients, fish oil use was associated with a significantly reduced risk of all-cause cardio-vascular mortality and long life expectancy (Tianqi Maet al, 2022).

Exposure to psychosocial stress is a risk factor for human diseases such as depression. Fish oil, which is rich in docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), is expected to lower the risk of depressive disorders. Fish oil improves psychosocial behavioral disorders caused by stress. This improvement could be explained by increased serotonin synthesis (Airi Otsukae et al, 2022).

Fish oil use has been associated with lower risks of all-cause dementia and vascular problems, independent of traditional risk factors and genetic risk factors. In addition, the associations between fish oil use and all-cause dementia risks and vascular problems were found to be favorable (Hao Ma et al, 2022).

MATERIAL AND METHOD

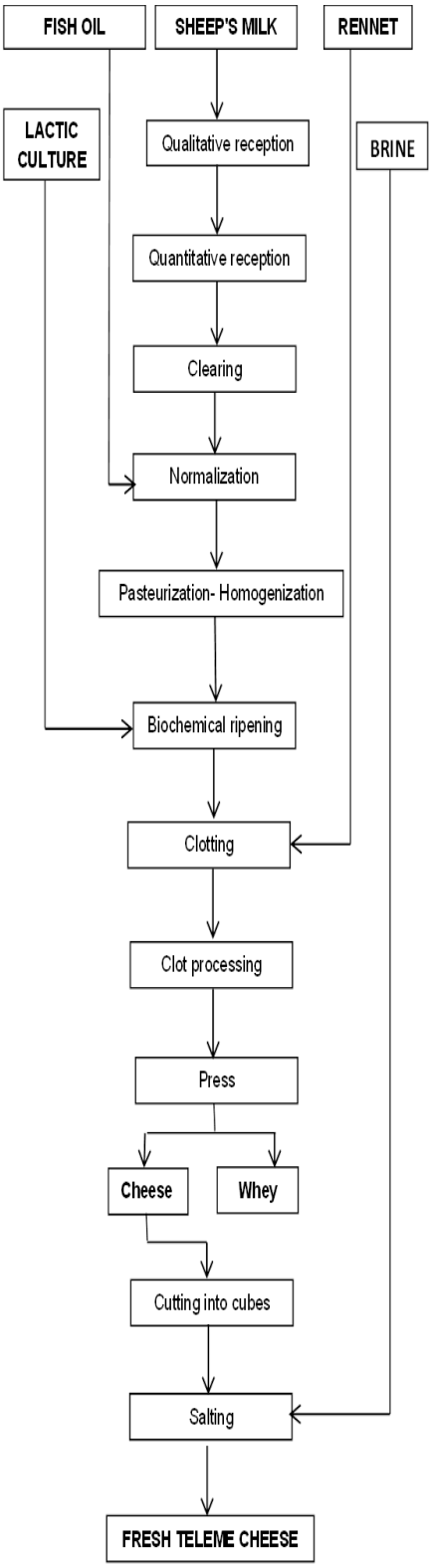
Fresh telemea cheese enriched in essential fatty acids was used in this study.

The raw material was sheep's milk from Bihor county collected in April, during the first lactation period. To enrich the finished product in essential fatty acids, fish oil was added to the milk. 4 samples were performed with increasing additions of 0%; 0.05%; 0.10% and 0.15%. In order for the fish oil to be embedded in the globule of milk fat molecules, the mixture of milk and fish oil was subjected to a homogenization process at temperatures of 70 ^{0}C and pressure of 200 Bar.

In the homogenization process, the membranes of fat globules are split 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 an organoleptic point of view and no deficiencies were observed regarding its appearance, color, taste and aroma.

Block diagram of cheese manufacturing technological operations



To obtain the yogurt, 100 liters of sheep's milk were used. In 25 liters no fish oil was added. In the next samples of 25 liters each, fish oil was added in increasing proportions of 0.05%; 0.10% and 0.15%. These quantities were used because they are are necessary in the pasteurization installation. This installation is brought to the thermal regime of pasteurization with water and then milk is introduced. The milk is diluted in smaller quantities.

After pasteurization and homogenization, the milk cooled to 47^0C was inoculated with a specific lactic culture produced by Chrisian Hansen, shared in packaging and biochemically matured at a temperature of 43^0C for 3 hours. The obtained products were analyzed from a sensory, physico-chemical point of view and 19 fatty acids were determined by gas chromatography.

Milk was also analyzed physico-chemically:

- 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 the possible thermal precipitation of the protein that can block the analysis equipment and used in the technological process is also checked;
- 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 acid-butyrometric method and the fat reported to the dry substance;
- the percentage of proteins by the Kjeldahl method.

19 fatty acids from the composition of milk and cheese samples were analyzed by gas chromatography. Fatty acids from fish oil were also analyzed.

Three essential fatty acids specific to both sheep's milk and fish oil were considered for the analysis of fish oil incorporation in cheese samples. S-au analizat statistic acidul linoleic (ω6), linolenic (ω3), şi γlinolenic (ω3),

RESULTS AND DISCUSSIONS

Through the sensory analysis of the samples, a fishy taste and aroma was noticed in

the samples with 0.10% and in those with 0.15%, which disappeared after approximately 3-4 days of storage.

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

Coding of samples

No. cr.	Add fish oil %	Sample code	
		Teleme	Fish oil
1	0	Tp_0	FO
2	0,0,5	$Tp_{0,05}$	FO
3	0,10	$Tp_{0,10}$	FO
4	0,15	$T_{0,15}$	FO

The physico-chemical analysis of the samples showed that the physico-chemical properties of the samples are not influenced by the addition of fish oil.

Regarding the fatty acid concentration, it was appreciated for the three fatty acids for the four telemea samples compared to fish oil.

Concentrations are reported as total fatty acids.

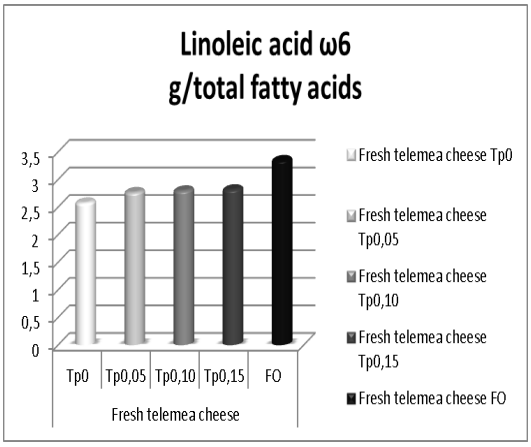


Figure 1 **Concentration of linoleic acid (ω6)in fresh teleme cheese samples compared to fish oil% of total fatty acids**

Linoleic acid from fish oil is found in telemea samples at a rate of 15.7% in the Tp0.05 sample; of 18.3% in the Tp0.10 sample; and by 20.2% in the Tp0.15 sample compared to the Tp0 sample without the addition of fish oil (figure 1).

Regarding linolenic acid, the situation is as follows: in the Tp0.05 sample it is found in a proportion of 13.3%, in the sample with Tp0.10 in a proportion of 25.3% and in the Tp0.15 sample in a proportion of 34.4% (figure2).

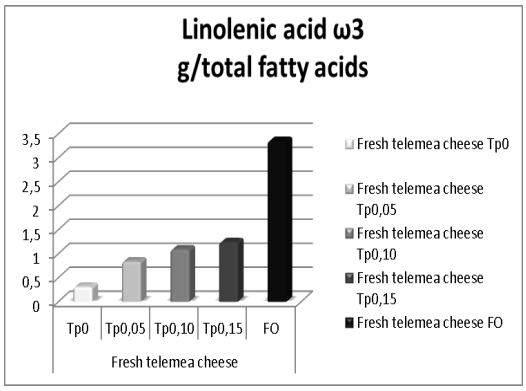


Figure 2 **Concentration of linolenic acid (ω3) in fresh teleme cheese samples compared to fish oil % of total fatty acids**

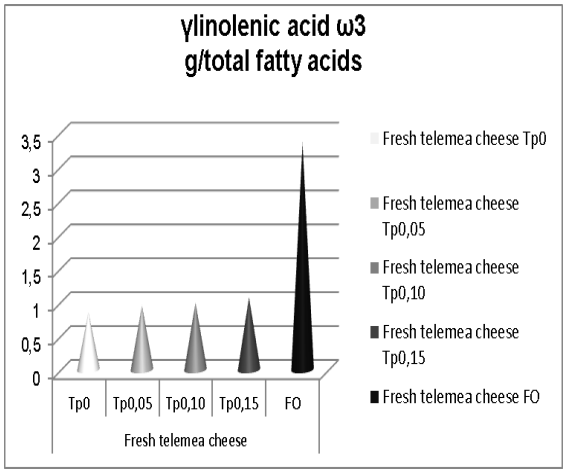


Figure 3 **Concentration of γlinolenic acid (ω3) in fresh teleme cheese samples compared to fish oil % of total fatty acids**

The γ-linolenic acid from fish oil is found in telemea samples in a proportion of 2.8% in the Tp0.05 sample; of 4.13% in the Tp0.10 sample; and 7.02% in the Tp0.15 sample compared to the Tp0 sample without the addition of fish oil (figures 3).

Figure 4 shows the chromatograms of the studied essential fatty acids that fall between those of raw milk and fish oil.

This shows that the essential fatty acids in the fish oil were incorporated by the milk fat globule membrane and subsequently into the fresh teleme cheese.

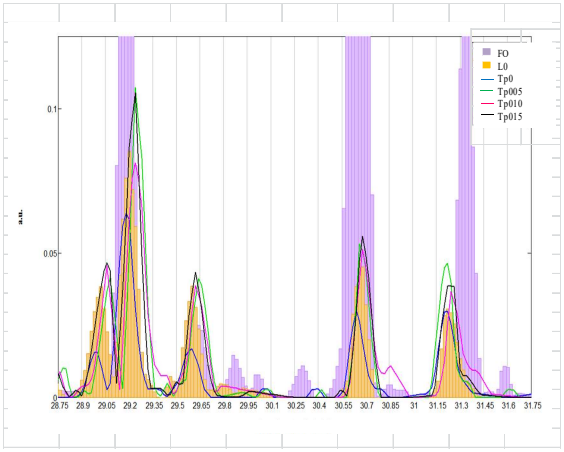


Figure 4 Graph of superimposed chromatograms of fresh telemea samples with and without addition and fish oil - the detection zone of the studied essential fatty acids

CONCLUSIONS

Teleme cheese obtained by adding fish oil to the raw material milk followed by homogenization of the mixture does not differ much from an organoleptic point of view compared to that without the addition of fish oil. The chemical characteristics of the finished product are not influenced by the addition of fish oil.

Regarding the three essential fatty acids in fish oil, they are found in the samples of fresh Teleme cheese.

Linolenic acid (ω3) is found in the highest proportion, followed by the proportion of linoleic acid (ω6) and γlinolenic acid (ω3).

The fishy taste and aroma could be removed by deodorizing the milk.

Embedding the fat from the fish oil in the milk fat globule could favor its assimilation by the human body.

Thus, it could benefit from the essential amino acids from the lactic protein, from the bacteria from the lactic culture used to make the cheese (min 10^6 cfu/g), but also the fatty substance from the cheese would have a higher nutritional and biological value.

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