PHYSICAL AND CHEMICAL CHARACTERIZATION OF MASCARPONE CHEESE WITH FISH GELATIN AS A FAT SUBSTITUTE

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ABSTRACT
Mascarpone cheese is a type of cheese with high fat content and a mild flavor. These features make this cheese an ingredient commonly used in many and different food products. However, these products usually have high fat and sugar contents. This, coupled with the mascarpone fat content, makes them nutritionally unattractive. This study describes the effect of adding gelatin from marine wastes as a fat substitute in mascarpone cheese and its impact on rheological and textural properties of this cheese. Six different samples of mascarpone cheese were prepared, where two fish gelatins (yellowfin tuna and blue shark) were tested as partial fat replacers, at two different percentages: 15% and 25%; a commercial product was included for comparative purposes. The results showed, for both marine species, reduced fat content, when compared to the control. The samples with yellowfin tuna gelatin had similar rheological and textural properties, when compared with control and commercial product. However, the mascarpone cheese with blue shark gelatin had less softness. The color was not affected by the inclusion of gelatin. In general, the addition of 15% gelatin showed a strong similarity to the commercial product and the control sample, and the sample with 15% tuna gelatin showed the best results from both sensorial and nutritional points of view.

Keywords: mascarpone cheese; fat; fish gelatin

INTRODUCTION
Mascarpone cheese, like ricotta cheese, is a non-ripened type of cheese produced by a combination of chemical acidification and heat treatment [1,2]. It does not need a starter culture, as the majority of other cheeses that require a mesophilic culture [2], [3].
Cheeses manufactured with the use of heat are produced by heating the milk, whey or milk skin until the whey proteins are denatured, usually at 85 ºC for 30 minutes, by means of an organic acid (e.g. citric, acetic, lactic acids) [1]. As a result of this reaction of protein denaturation, the whey proteins remain largely in the cheese matrix for 20 hours of draining steps [1]. This and other cheeses produced with the use of heat and with acidification have a pH value between 5 and 6, unlike the other cheeses that have a lower pH (pH = 4,6) [2], [3]. This component gives a decreased firmness in soft cheeses [3]. The mascarpone cheese has been increasingly used as a food ingredient and mainly in products like desserts, bagels, dips and flavoured spreads because

of its fat content, in the range of 70 to 80% [3].However, given the increasing concern of the population about having healthier and sustainable food products, it would be interesting to produce a mascarpone cheese with lower fat content and with similar rheological characteristics, texture and flavour. This can be achieved by replacing part of the milk skin by gelatin, since gelatin has an emulsifier, thickener, gelling and also stabilizing capacity, which enables the mascarpone production with a lower fat content. Therefore, the aim of this study was to analyse the rheological and textural proprieties of mascarpone cheese with the addition of gelatin from fish skins (yellowfin tuna, *Thunnus albacares*, and blue shark, *Prionace glauca*) as a replacement of the milk skin. This will allow understanding how the rheological and textural proprieties of macarpone cheeses are affected by different levels of fat, as well as by the addition of fish gelatin.

MATERIAL AND METHODS

Mascarpone Cheese Samples

Six different samples were prepared with mascarpone cheese, where two fish gelatins (yellowfin tuna and blue shark) were tested: commercial mascarpone cheese, control (0% fish gelatin), yellowfin tuna 15% (T15), yellowfin tuna 25% (T25), blue shark 15% (S15) and blue shark 25% (S25). The UHT (ultra-high temperature) cream (30% fat) was heated in a water bath up to 86 ºC. Then, 6 mL of citric acid were added and it was mixed for 10 minutes until curdling of the mixture. Thereafter, it was subjected to a rapid cooling and it was drained for 24 hours at 4 ºC. Gelatin solutions of 6.67% (w/v) were added, in the previously mentioned percentages, along with the creams, except on control.

Protein

The protein was analyzed based on the kjeldahl method for the determination of the nitrogenous substances. A 200 mg sample was digested at 400 °C with 4 mL of H_2SO_4. The reaction was stopped with the addition of 20 mL deionised water. After it was distilled in a kjeltec sysytem (1002 distilling unit from Tecator^{TM}), boric acid solution was added until reaching a final volume of 150 mL. Then, titling with HCl 0.2 N was performed, to turn violet to orange.

Fat Content

Total lipids were determined according to the Folch method [4]. Briefly, 10 mL of chloroform/methanol (2:1 v/v) solvent mixture were added to 1 g of sample and vortexed for 15 seconds. Then, the mixtures were sonicated for 30 min, 5 mL of solvent mixture and 5 mL of deionized water were added, shaken vigorously for 2 min, and centrifuged at 5,000 rpm for 5 min, at 4 ºC. The resulting lower phase was transferred to a previously weighted glass balloon and the procedure was repeated with the remaining sample. The lower phases were pooled and the solvent was evaporated at 37 ºC. The glass balloon was then weighted to calculate the fat content.

Color

Color analysis was performed with a colorimeter (Chroma Meter CR-400, from Konica Minolta, Japan). The measured parameters were L* (lightness), a* (green to red) and b* (blue to yellow). With the obtained values it was possible to calculate two other parameters: C (saturation) and Hue (color). For each sample measurements were performed in three different sites.

Rheological Analysis and Textural Analysis

Rheological measurements were performed on a Gemini Advanced Rheometer (Bohlin Instruments, UK), coupled with a peltier unit. Linear viscoelastic region was determined (results not shown) and a frequency of 0.1 Hz and a strain of 0.05% were utilized. Analysis were performed at 8 ºC. The parameters assessed were the phase angle and the storage, or elastic, modulus (*G´*).Texture was analyzed in a TA.XT*plus* Texture Analyzer (Stable Micro Systems, UK) with a 5 Kg load cell. For softness, a 5 mm diameter cylinder probe, with a penetration speed of 1.0 mm/s and a penetration depth of 10 mm, was utilized. To measure firmness and stickiness, a 0.6.35 mm diameter spherical probe, with a penetration speed of 2.0 mm/s and a penetration depth of 5 mm, was utilized. Analysis were performed in triplicate.

RESULTS AND DISCUSSION

Protein

Protein content of each sample is shown in Table 1. Results showed that significant differences were only found in the samples with 25% gelatin. Blue shark 25% had slightly higher protein content than S15 and the commercial sample, and T25 had the highest content.

Fat Content

Results (Table 1) revealed that those samples with higher fat content are the control and T25. Control and blue shark samples presented similar values. Blue shark gelatin incorporation had a positive effect, reducing the fat content of the mascarpone cheese when compared with the commercial sample.

Color

The objective color values selected for measurement enable a description of the visual appearance of the products. The results for color measurements of samples are presented in Table 1 and showed, for every parameter, only slight differences between samples.

Table 1 – Fat, protein and color measurements of mascarpone cheese samples.

Sample	Fat [mg/g]	Protein [g/Kg]	Color L*	Color C	Color Hue
Commercial	425 ± 60	5.7 ± 1.5	72.3 ± 1.4	8.8 ± 0.1	102.0 ± 0.1
Control	628 ± 74	6.8 ± 2.6	61.5 ± 4.9	10.6 ± 0.6	99.7 ± 0.1
T15	465 ± 110	6.9 ± 0.5	75.5 ± 0.0	10.8 ± 0.0	101.7 ± 0.1
T25	603 ± 34	11.4 ± 0.4	74.6 ± 1.0	12.3 ± 0.2	103.7 ± 0.1
S15	491 ± 54	6.2 ± 0.4	67.9 ± 5.5	10.1 ± 0.7	100.8 ± 0.1
S25	369 ± 91	8.6 ± 1.5	69.2 ± 5.4	11.2 ± 1.0	100.8 ± 0.1

Rheological and Textural Analysis

Regarding rheological properties, Table 2 shows the average for elastic modulus and phase angle for each sample. The softer samples in descending order are commercial, control, T15, T25, S15 and S25. The stickiness is higher in Q15 sample.

Table 2 – Rheological and texture properties of the samples.

Sample	Rheology		Texture		
	Phase Angle [º]	Elastic Modulus (G´) [Pa]	Softness [g]	Hardness [g]	Stickiness [g]
Commercial	16.9 ± 2.2	3767 ± 346	66.1 ± 3.5	52.9 ± 4.2	-14.9 ± 1.0
Control	25.3 ± 0.03	3307 ± 154	58.7 ± 11.2	46.3 ± 8.4	-17.0 ± 3.3
T15	21.6 ± 5.3	800 ± 1049	55.3 ± 8.3	44.0 ± 8.9	-19.5 ± 4.2
T25	15.1 ± 0.5	305 ± 81	51.5 ± 6.9	36.2 ± 3.0	-21.8 ± 1.2
S15	18.7 ± 2.2	504 ± 71	42.4 ± 18.9	30.8 ± 8.5	-16.8 ± 7.4
S25	11.1 ± 1.6	3113 ± 284	28.0 ± 15.8	23.9 ± 6.3	-11.8 ± 6.3

Conclusion

The sample with more rheological and textural similarities with the commercial product, as well as less fat and adequate protein contents, was the sample with 15% tuna gelatin.

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