EFFECTS OF ADDITION OF CANOLA OIL AND INULIN PRE EMULSIONS IN SALAMIS: FATTY ACID COMPOSITION AND LIPID OXIDATION

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Abstract – Pork back fat is considered the major source of fat in fermented dry sausages and its reduction or substitution by vegetable oil stand for a great challenge to improve the nutritional properties of these products. In this study, pork back fat was partially replaced by canola oil and inulin to modify lipid profile and also bring functional benefits. We evaluated the effects of this reformulation in salamis using pre emulsions of canola oil and inulin on proximate composition, fatty acid composition and lipid oxidation. Four treatments were manufactured, FC-control, F1- reducing 50% of pork back fat + blend of canola oil; F2 – F1 + 2,5% inulin and F3 – F1 + 5,0% inulin. Lipid oxidation results indicated that higher (P<0,05) values of malondialdehyde were found in treatments containing canola oil (F1, F2 and F3). Regarding fatty acid composition, the addition of canola oil reduced about 30% saturated fatty acids and improved mono and polyunsaturated fatty acids. These results suggest that the pork back fat reduction was successful although further studies are necessary to assess sensory properties and lipid oxidation in shelf life.

Key Words – fermented sausages, canola oil, inulin, lipid profile

I. INTRODUCTION

Meat industry is considered one of the most important of the world and the search for developing new products is continuous [1]. However, meat and meat products are also related to negative nutritional profile due to high saturated fatty acids, cholesterol and sodium content [2], among others.

In fermented dry sausages, such as Brazilian salamis, fat contributes to development of texture and flavor, but can reach about 50% of product owing to water loss during processing period [3]. Several fat substitutes have been studied, such as vegetable oil [4] and fiber [5], however, this reformulation represents a great technological challenge.

In salamis, animal fat could be replaced using a pre emulsion systems [6], resulted from an appropriated mix of vegetable oil, isolated soybean protein or other sources and water. However, to develop complex systems when pork back fat in pre emulsion is added, another stabilizer is need, such as carrageenan, which is a hydrocolloid and has gelation properties [7].

Among the fat substitutes, the addition of vegetable or marine oils in meat products is considered a good strategy to increase levels of poly-unsaturated fatty acids (PUFA), once consumers need a balance between saturated, mono and poly unsaturated fatty acids [8]. Canola oil is a good source of α-linolenic acid, and has the lowest levels of saturated fatty acids when compared to other vegetable oils [9]. And inulin is considered as a functional fiber that could be used as fat replacer due to its characteristics of water holding capacity and gelation properties.

Therefore, the aim of this study was to develop Brazilian salamis added of canola oil and inulin and to evaluate the effects on proximate composition, the lipid profile and lipid oxidation after this reformulation.

II. MATERIALS AND METHODS

Three independent replicates of each treatment of Brazilian salamis were manufactured. The control treatment was prepared with pork (820 g/kg) and pork back fat (180 g/kg) as the raw materials. The reformulated products were prepared with pork (820 g/kg) and pork back fat (90.5 g/kg being 50 g/kg added in batter and 40.5 g/kg added in pre emulsion form). The pre emulsion (130 g/kg) was manufactured with water (40.5 g/kg), isolated soybean protein (8 g/kg), canola oil (40.5 g/kg) (Cargill Foods, São Paulo, Brazil), pork back fat (40.5 g/kg), carrageenan (0.2 g/kg) and sodium tripolyphosphate (0.3 g/kg). The following ingredients were added to the meat mixture in each treatment: sodium chloride (25 g/kg), glucose (5 g/kg), sucrose (5 g/kg), sodium nitrate (0.15 g/kg), sodium nitrite (0.15 g/kg), sodium ascorbate (0.25 g/kg), white pepper (2 g/kg), garlic (3 g/kg), nutmeg (0.02 g/kg) and Starter T-SPX (Chr. Hansen, Valinhos, São Paulo, Brazil) (0.25 g/kg). Concentrations of 0% (F1), 2,5% (F2) and 5% (F3) inulin (Clariant S/A, São Paulo, Brazil) were added to reformulated Brazilian salamis.

All proximate composition analysis was performed in triplicate. Proximate composition (moisture, protein, fat and ash contents) was performed according to the Association of Official Analytical Chemists [10]. Carbohydrates were calculated by difference [11].

The TBA values were expressed after absorbance reading at 532 nm as mg of malondialdehyde (MDA) per kg sample [12].

Lipid phase of reformulated Brazilian salamis was extracted as describes by Bligh & Dyer [13] followed by Hartman & Lago [14] method of esterification. Fatty acid composition was performed in capillary gas chromatograph column CGC 6850 Series GC System (Agilent, Santa Clara, California, EUA). Fatty acid methyl esters were separed according to AOCS Ce 2-66 method [15] in capillary column DB-23 Agilent (50% cyanopropyl-methylpolysiloxane) dimensions 60 m, Øint: 0,25 mm, 0,25 µm film thickness. The oven temperature began at 110 ºC at 5 min, ramped to 215 ºC at 5 ºC/min, held at 215 ºC at 24 min; detector temperature was set at 280 ºC, helium was used as carrier gas.1 µl was injected in split injector (split ratio 1:50) set at 250 ºC.

The data obtained were subjected to analysis of variance (ANOVA), and the comparison between means was determined by Tukey's test with 5% significance level. These statistical analyses of data were carried out using statistical software SPSS [16].

III. RESULTS AND DISCUSSION

The results of proximate composition (0 and 21 days) and lipid oxidation (0, 7, 14 and 21 days) are shown in Table 1.

Moisture values of reformulated Brazilian salamis added of canola oil and inulin were significant different ($P<0,05$) from control treatment, probably due to water addition in pre emulsion. However, at the end of the process (day 21) no significant differences were found ($P>0,05$). Protein content was not affect by the reformulation either, although protein levels of reformulated products were slightly higher (probably due to 0,8% isolated soybean protein added in pre emulsion) ($P>0,05$).

Additionally, lipid reformulation in Brazilian salamis resulted in reduction around 33% of fat at the start of manufacturing process (day 0) compared to control ($P<0,05$) and a decrease of 20% at the end of the process (day 21).

The increase of carbohydrates level was expected and resulted from the addition of 2,5% and 5% of inulin. Besides, glucose and sucrose are also considered carbohydrates, explaining the presence of carbohydrates in treatments control and F1.

Along the lipid oxidation process, several products are produced, including malondialdehyde (MDA), a hydroperoxide decomposition product of poly-unsaturated fatty acids (PUFA) [17]. The values of TBARS test at the day 0 and at the day 21, in samples from treatments containing canola oil were significant higher ($P<0,05$) when compared to control, indicating that canola oil addition promoted higher lipid oxidation in reformulated Brazilian salamis.

The main fatty acids reported in all treatments according Table 2 were: palmitic (C16:0) and estearic acid (C18:0) (SFA – saturated fatty acids), oleic acid (C18:1) (MUFA – monounsaturated fatty acid) and linolenic. In

Table 1. Proximate composition and TBA values of reformulated Brazilian salamis

	Days	Control	F1	F2	F3
Moisture (%)	0	59,36±0,15^{c}	64,32±0,34^{a}	64,14±0,32^{a}	62,22±0,65^{b}
	21	35,23±0,15	35,91±0,61	35,99±0,63	35,24±0,47
Protein (%)	0	18,54±0,03	18,58±1,47	18,29±1,47	18,06±1,06
	21	31,44±0,33	32,97±0,71	32,77±0,45	32,17±1,02
Fat (%)	0	17,95±0,67^{a}	12,82±0,19^{b}	11,98±0,53^{b}	11,93±0,81^{b}
	21	27,34±0,22^{a}	23,97±0,94^{b}	21,81±0,37^{c}	21,93±0,45^{c}
Ash (%)	0	3,14±0,22^{b}	3,34±0,12^{ab}	3,49±0,06^{a}	3,37±0,03^{ab}
	21	4,54±0,20	4,93±0,14	4,69±0,12	4,79±0,10
Carbohydrate (%)	0	1,01±0,32^{c}	0,94±0,21^{c}	2,1±0,24^{b}	3,42±0,33^{a}
	21	1,45±0,31^{d}	2,22±0,22^{c}	4,74±0,10^{b}	5,88±0,12^{a}
TBA	0	0,212±0,005^{bB}	0,328±0,041^{aB}	0,323±0,011^{aC}	0,327±0,010^{aC}
	7	0,226±0,013^{bB}	0,333±0,017^{aB}	0,346±0,025^{aB}	0,349±0,015^{aB}
	14	0,222±0,007^{cB}	0,364±0,008^{bA}	0,455±0,008^{aA}	0,463±0,011^{aA}
	21	0,293±0,019^{cA}	0,366±0,011^{bA}	0,466±0,018^{aA}	0,469±0,016^{aA}

Note: Values represent the average (±standard deviation). Averages with the same letter on the same row are not significantly different (P > 0.05) by Tukey's test. Averages with the same letter on the same column are not significantly different (P > 0.05) by Tukey's test (only TBA values). FC1- 100% pork back fat; F1- 50% pork back fat + blend containing canola oil; F2-50% pork back fat + blend containing canola oil and 2,5% inulin; F3- 50% pork back fat + blend containing canola oil and 5% inulin.

treatments where canola oil was added (F1, F2 and F3), SFA total was lower (P<0,05) than control, as expected. The addition of canola oil with simultaneous pork back fat reduction resulted in an improved in lipid profile due to decrease of SFA (30%), and higher MUFA and PUFA values. In reformulated Brazilian salamis, the level of acid α-linolenic was improved about three times by adding this oil as a result of canola oil addition.

PUFA/SFA ratio was improved in almost 60% due to addition of canola oil in treatments were reformulation was made.

IV. CONCLUSION

The addition of canola oil in reformulated products improved n6/n3 ratio in almost 50% and resulted in decreasing of SFA. Despite the higher TBA values in salamis from treatments containing canola oil as a partial substitute of pork back fat, benefits on nutritional status could be considered to suggest this reformulation to meat industry and further studies adding antioxidant compounds to reduce risks of undesirable oxidation.

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Table 2. Mainly fatty acids in reformulated Brazilian salamis added by canola oil and two levels of inulin

Fatty acid/Sum/Ratio	Days	Control (%)	F1 (%)	F2 (%)	F3 (%)
C16:0	0	19,68^{a}	14,60^{b}	14,51^{b}	14,14^{Bb}
	21	19,79^{a}	14,52^{b}	14,41^{b}	14,61^{Ab}
C18:0	0	11,36^{a}	7,21^{Ac}	7,38^{Bc}	8,04^{Ab}
	21	11,39^{a}	7,11^{Bc}	7,53^{Ab}	7,09^{Bc}
SFA	0	33,68^{a}	23,55^{c}	23,47^{c}	24,13^{b}
	21	33,97^{a}	23,71^{b}	23,69^{b}	23,96^{b}
C18:1	0	38,38^{c}	46,18^{Aa}	46,24^{a}	45,36^{Bb}
	21	38,60^{c}	46,10^{Ba}	46,22^{a}	45,58^{Ab}
MUFA	0	41,44^{b}	48,77^{a}	48,77^{a}	48,16^{a}
	21	41,29^{b}	48,70^{a}	48,93^{a}	48,42^{a}
C18:2	0	22,48^{b}	23,75^{a}	23,78^{Aa}	23,76^{a}
	21	22,35^{b}	23,79^{a}	23,31^{Ba}	23,58^{a}
C18:3	0	1,10^{c}	2,96^{b}	3,25^{Aa}	2,97^{b}
	21	1,20^{b}	2,90^{a}	2,99^{Ba}	2,97^{a}
PUFA	0	24,88^{b}	27,67^{a}	27,77^{a}	27,71^{a}
	21	24,74^{b}	27,79^{a}	27,38^{a}	27,62^{a}
PUFA/SFA	0	0,74^{b}	1,18^{a}	1,18^{a}	1,15^{a}
	21	0,73^{b}	1,18^{a}	1,16^{a}	1,15^{a}
n6/n3	0	14,25^{a}	7,39^{b}	6,75^{Bb}	7,37^{b}
	21	13,73^{a}	7,50^{b}	7,24^{Ab}	7,24^{b}

Averages with the same letter on the same row are not significantly different (P > 0.05) by Tukey's test. Averages with the same letter on the same column are not significantly different (P > 0.05) by Tukey's test. FC1- 100% pork back fat; F1- 50% pork back fat + blend containing canola oil; F2-50% pork back fat + blend containing canola oil and 2,5% inulin; F3- 50% pork back fat + blend containing canola oil and 5% inulin.

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