TECHNOLOGICAL PROPERTIES OF RESISTANT STARCHES AS FAT REPLACER IN BOLOGNA SAUSAGE

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Abstract – Changes in consumer demand and the increase of competition in the global food market has led meat product industries to adopt new processing technologies by using new ingredients to add value, especially in health attribute. In this context, the resistant starches are compounds that exhibit properties similar to prebiotic fibers, with the same physiological function, however very little studied in meat products regarding its technological functions. The aim of this study was to evaluate the use of resistant starches in emulsified meat product with reduced fat to obtain a final product with healthy appeal. The resistant starches, type 2, 3 and 4 were tested for their ability to retain water with the same results of others extenders already used in meat products. Resistant starch type 3 was chosen to be evaluated against three different levels of addition: 3, 6 and 9%, because have a good thermal stability on processing. Te best results regarding cooking loss, texture profile and color were found when 3 and 6 % resistant starch type 3 was added in bologna sausage formulations.

Key words – Meat emulsion, Prebiotic dietary fiber, Texture profile

I. INTRODUCTION

Changes in consumer demand and the increase of competition in the global food market has led meat product industries to adopt new processing technologies using new ingredients to add value, with healthy appeal, such as fat reduction or replacement. However, these strategies may result in formulations with lower microbial stability, sensory acceptance and water holding capacity, commonly difficult to be compensated [1].

Consumer interest in specific foods which help in maintaining health has grown in recent years. The term "functional foods" refers to these foodstuffs, which can provide nutritional benefits, dietary and metabolic specific, and contribute to control and reduce risk of disease [2].To follow with market trends meat products can be added with functional and healthy ingredients [3]. Bologna sausage is the most important meat product produced in Brazil [4], and its fat content usually found ranges from 20 to 35%. These fat levels are correlated to incidence of some chronic diseases. Many studies had reported the challenge to reduce this high fat level, in particular from pork backfat.

The development of meat products with low fat consists to provide a combination of ingredients to replace animal fat without changes on physicochemical and sensorial properties. The fat reduction content implies to use of non-meat ingredients which allow replacing fat by water [5].

Dietary fibers have been widely reported in the literature as non-meat ingredient with potential use as fat substitute with additional effect on health as a function of the physiological metabolic effects [6]. The fibers used in meat products result in reduced caloric value and can be used as partial fats substitutes. Many of them have excellent water holding capacity, neutral odor and can improve sliced products quality. Furthermore, incorporation of water and fibers in formulations results in low cost meat products [7].

In this context, resistant starches are compounds that exhibit properties similar to the fibers, for having the same physiological function, being much less studied as ingredients in meat products. The aim of this study was to evaluate the technological properties of different types of resistant starches regarding its water holding capacity and texture profile, when used in different levels in emulsified meat product.

II. MATERIALS AND METHODS

Selection of resistant starches: Four samples of resistant starches were selected: Hi Maize ® 260 - resistant starch type 2, PROMITOR ® - resistant starch type 3 and Novelose ® - 480 HA resistant starch type 4 (National Starch and Tate & Lyle) and green banana flour, resistant starch type 2 acquired on market. The samples were tested in emulsified meat model system, to evaluate the technological property of water holding capacity. The results were compared with other extenders already used in meat industry as isolated soybean protein and cassava starch. The water holding capacity evaluation was performed as described by SMITH et al. [8] with the changes proposed by OLIVO [9].

Treatments: Five formulations were prepared with two controls: FC1 (20% fat and 3% of cassava starch) and FC2 (10% fat and 3% of cassava starch). The other formulations were prepared with different addition levels of resistant starch type 3 (PROMITOR ®): F1 (3%), F2 and F3 with 6% to 9% and not more than 10% of fat and without addition of cassava starch. The formulations are described in Table 1. The Bologna sausages were prepared by the conventional process.

Analysis performed: Cooking loss was determined according HORITA [4]. Texture profile analysis was performed according to Bourne [10] using a TA-xT2i Texture Analyzer, (Stable Micro Systems Inc. Godalming, UK) coupled to a microcomputer equipped with Texture Expert Software. A P-35 probe was used (long shaft, regular base). All samples were compressed to 30% of their original weight. Six 20-mm thick and 20-mm long portions were used for each treatment. A P-35 probe was used (long shaft, regular base). The following parameters were determined: hardness (N), elasticity (cm), cohesiveness, and chewiness (N/cm) using a compression velocity of 1.0 mm/s. Measurements were made at room temperature.

Color was measured using a Minolta CR 580 colorimeter with a 20-mm port size, illuminant D65 and 2 absv parameter. CIELAB L*, a*and b* values were determined as indicators of lightness, redness and yellowness. Color variables were measured at three points on the central part of the cut surface of one slice per piece of bologna sausage. Assays were performed in triplicate for each treatment. All samples were maintained at room temperature during the analysis. The data were evaluated through variance analysis (ANOVA). The averages were compared by Tukey's test at a confidence level of 5% ($p<0.05$) using STATISTICA 7.

III. RESULTS AND DISCUSSION

Water Holding Capacity: Water holding capacity of resistant starches of Novelose HA ® 480 and Hi Maize ® 260 showed no significant difference between the results. Following resistant starch type 3 PROMITOR ® had a slightly larger value and green banana flour showed the highest result, as shown in Table 2. When compared with other traditional extenders such as isolated soybean protein, BARRETTO [7] found a value of 61.25%, similar to the resistant starch type 3. KHALIL [11] has conducted tests of partial and total substitution of fat by meat corn starch in molded and reported values: 62.90% control 65.64% in partial substitution of 25% and 81.39% by 100% replacement. The results of water holding capacity from all ingredients tested showed potential as a fat substitute ingredient. Resistant starch type 3 (Promitor ®) was selected to be tested as extender ingredient in low fat Bologna sausage formulations because of its exceptional thermal properties on processing.

Texture profile: There was no difference for cohesiveness and elasticity results regarding texture profile analysis presented in Table 3. It shows that all formulations and controls did not differ significantly according to Tukey test ($p < 0.05$).

Table 2. Values of water holding capacity (%) of different resistant starches.

Resistant starches	WHC (%)
Novelose ®480 HA	$58{,}03 \pm 0{,}48^c$
Hi maize ®260	$58{,}57 \pm 0{,}39^c$
Promitor ®	$60{,}51 \pm 0{,}41^b$
Green banana flour	$86{,}99 \pm 0{,}19^a$

Values are the mean (standard deviation).
Means in the same column with the same letters did not differ significantly at $p<0.05$ (Tukey's test).

Table 1. Formulations (%) of low fat Bologna sausages with different levels of resistant starch type 3.

Components	FC1 (%)	FC2 (%)	F1 (%)	F2 (%)	F3 (%)
Lean beaf	37,90	37,90	40,50	40,50	40,50
Pork	17,54	17,54	17,54	17,54	17,54
Pork backfat	20,00	10,00	10,00	10,00	10,00
Ice	14,60	24,60	21,90	19,00	16,00
Sodium tripolyphosphate	0,30	0,30	0,30	0,30	0,30
Sodium nitrite	0,015	0,015	0,015	0,015	0,015
Salt	2,00	2,00	2,00	2,00	2,00
Sodium erythorbate	0,05	0,05	0,05	0,05	0,05
Bologna condiments	0,52	0,52	0,52	0,52	0,52
Grounded black pepper	0,02	0,02	0,02	0,02	0,02
Isolated soybean protein	3,60	3,60	3,60	3,60	3,60
Cassava starch	3,00	3,00	0,00	0,00	0,00
Garlic powder	0,40	0,40	0,40	0,40	0,40
Carmim cochonilha colorant	0,06	0,06	0,06	0,06	0,06
Resistant starch type 3	0,00	0,00	3,00	6,00	9,00

FC 1 – Control formulation (20% fat and 3% of cassava starch).
FC 2 – Control formulation (10% fat and 3% of cassava starch).
F1– 10% fat and 3,0 % resistant starch type 3 (Promitor®)
F2- 10% fat and 6,0 % resistant starch type 3 (Promitor®)
F3- 10% fat and 9,0 % resistant starch type 3 (Promitor®)

Table 3. Texture profile analysis, cooking loss (%) and color L*a*b* of low fat Bologna sausages with different levels of resistant starch type 3.

	Hardness (N)	Cohesiviness	Elasticity (cm)	Chewiness (N/cm)	Cooking Loss (%)	Color L*	Color a*	Color b*
FC1	26,10±4,29[b]	0,82±0,04[a]	0,91±0,03[a]	19,48±4,49[b]	8,50±0,29[d]	63,68±1,18[a]	12,88±0,35[b]	10,19±0,18[b]
FC2	22,21±1,39[c]	0,79±0,04[a]	0,90±0,01[a]	15,74±1,21[c]	10,55±0,41[b]	59,91±1,36[b]	14,6±0,38[c]	10,22±0,70[b]
F1	25,10±1,77[bc]	0,8±0,05[a]	0,90±0,02[a]	18,03±1,46[bc]	11,19±0,35[a]	57,11±0,94[c]	15,27±0,70[a]	9,79±0,27[b]
F2	26,42 ±1,51[b]	0,79±0,03[a]	0,91±0,005[a]	18,99 ±1,10[bc]	9,78 ±0,24[c]	59,39±0,65[b]	14,27±0,26[c]	10,85±0,31[a]
F3	33,37±2,11[a]	0,79±0,009[a]	0,91±0,009[a]	23,93±1,68[a]	9,69±0,23[c]	59,56±0,73[b]	14,60±0,24[c]	9,76±0,34[b]

Values are the mean (standard deviation).
Means in the same column with the same letters did not differ significantly at $p<0.05$ (Tukey's test).
FC 1 – Control formulation (20% fat and 3% of cassava starch).
FC 2 – Control formulation (10% fat and 3% of cassava starch).
F1– 10% fat and 3,0 % resistant starch type 3 (Promitor®)
F2 - 10% fat and 6,0 % resistant starch type 3 (Promitor®)
F3- 10% fat and 9,0 % resistant starch type 3 (Promitor®)

Regarding to hardness and chewiness, the formulation F3 with 6% resistant starch type 3 showed the highest values, and it was different from the others. The addition of 9% of this ingredient influenced the texture of the product with the highest values of hardness and chewiness reported ($p <0.05$).
F1 formulation with 10% fat and 3% cassava starch and F2 with 10% fat and 6% cassava starch showed no significant difference compared to FC1, control formulation containing 20% fat and 3% starch cassava. This demonstrates that the resistant starch type 3 PROMITOR ® at concentrations of 3 and 6% was a suitable fat replacer equivalent effect with no loss in product texture. The FC2, control formulation with 10% fat and 3% of cassava starch showed the lowest values of hardness and chewiness that did not differ significantly from the values of the formulation F1, demonstrating again that the resistant starch Promitor® at a concentration of 3 % is an equivalent substitute.
The results of cooking loss of the formulations are presented in Table 3. It was observed that greater amount of fat in control results in lower cooking loss. None of the formulations showed similar behavior to controls with cassava starch, showing that cooking loss differ from resistant

starch to cassava starch. In the same way, increasing the addition of resistant starch with the same amount of fat (10%) results in lower cooking loss and better stability. When comparing the same concentration of added starch and fat (3% and 10%), it can be stated that the resistant starch Promitor® presents greater loss than the cassava starch.

HUGHES [12] reported that the reduction in fat content of 5 to 30% significantly increased the cooking loss and decreased as the water holding capacity and emulsion stability.

Color evaluation of the formulations, as shown in Table 3, low fat reduced lightness values, increased a * values and did not change the b * values with the exception of formulation F2 that showed a higher value than FC2. FC2 and F3 formulations showed no significant differences according Tukey ($p < 0.05$) in L * a * b *. When the fat content is reduced and the meat content increased to compensate fat loss, the a* parameter value increases.

CONCLUSION

Resistant starches type 2, 3 and 4 can be used as replacers of Cassava starch because their water holding capacity values have similar results when compared between themselves. From the evaluation and implementation of the technological properties of resistant starches has been observed that the addition limit of resistant starch type 3 Promitor® was 6% in Bologna sausage.

REFERENCES

1. WEISS, J.; GIBIS, M.; SCHUH, V.; SALMINEN, H. Meat Science, v. 86, p. 196–213, 2010.
2. LOBO, A.R.; SILVA, G. M. L. Amido resistente e suas propriedades físico-químicas. Revista Nutrição, Campinas, v. 16(2): p. 219-226, abr-jun, 2003.
3. VANDENDRIESSCHE, F. Meat products in the past, today and in the future. Meat Science, v. 78, p. 104 – 113, 2008.
4. HORITA, C.N. Redução de cloreto de sódio em produto emulsionado tipo mortadela: influência sobre a qualidade global. 2010. 107p. Dissertação (Mestrado em Tecnologia de Alimentos) - Universidade Estadual de Campinas. Faculdade de Engenharia de Alimentos, Campinas, 2010.
5. JIMENEZ-COLMENERO, F. Technologies for developing low-fat meat products. Review. Trends in Food Science & Technology, Cambridge, v.7, p. 41-48, 1996.
6. CÁCERES, E.; GARCÍA, M. L.; TORO, J.; SELGAS, M. D. The effect of fructooligosaccharides on the sensory characteristics of cooked sausages. Meat Science, Barking, v. 68, p.87-96, 2004.
7. BARRETTO, A.C.S. Efeito da adição de fibras com substituto de gordura em mortadela. 2007. 163p. Tese (Doutorado em Tecnologia de Alimentos)- Universidade Estadual de Campinas. Faculdade de Engenharia de Alimentos, Campinas, 2007.
8. SMITH, C.G.; JUHN, H.; CARPENTER, Z.L.; MATTIL, K.F.; CATER, C.M. Efficacy of protein additives as emulsion stabilizers in frankfurters. Journal of Food Science, Chicago, v.38, n.5, p.849-855, 1973.
9. OLIVO, R. Uso do colágeno em emulsões cárneas. São Paulo, 1995. 120 p. Dissertação de Mestrado. Faculdade de Ciências farmacêuticas da USP.
10. Bourne, M.C (1978). Texture profile analysis. Food Technology 32: 62-72.
11. KHALIL, A. H. Quality characteristics of low fat beef patties formulated with modified corn starch and water. Food Chemistry, v. 68(1), p. 61-68, 2000.
12. HUGHES, S.; COFRADES & TROY, D. J. Effects of Fat Level, Oat Fibre and Carrageenan on Frankfurters Formulated with 5%, 12% and 30% Fat. Meat Science, Vol. 45, No. 3, 273-281, 1997.