MANUFACTURING PROCESS DEVELOPMENT ON A READY TO HEAT AND EAT PORTUGUESE TRADITIONAL PRODUCT: "MARANHOS"

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Background

Cooked meat products are generally marketed after having been heat-processed within the production facility. The application of heat to these products as a finishing production step, and before they are sliced and/or packaged, is necessary to make them easily digestible, to inactivate enzymes (e.g. lipasas) and microorganisms, and to give them a specific colour, taste and consistency (Hammer, 1991). In recent years there has been a tremendous growth in the chilled food market, with a wide variety of products available to the consumer through retail and catering outlets (HMSO, 1993). Safety is the prime consideration and food manufacturers must ensure that products pose a minimum hazard to the consumer. The safety required has to be achieved both by preventing the growth of pathogens during production and by reducing the remaining contamination to the lowest possible level (Barbuti & Parolari, 2002).

"Maranhos" is a goat meat sausage, traditionally home-made in Beira Baixa, a region in the centre of Portugal, where it is a very popular dish. It is a product with low price raw materials, easily perishable, with a reasonable composition and energetic value and low salt content. Although no pathogenic flora is usually present in the product, research on and counts of hygienic indexes are higher than desirable. Therefore, the microbiological quality of the product is low (Salavessa & Barreto, 2003).

Objectives

Research on manufacture of this type of product has been extremely limited, therefore this work aims to study the effect of pre-cooking on both the chemical and microbiological characteristics of "Maranhos".

Materials and methods

Three batches of this meat product were prepared in three different times, according to a traditional recipe and technological procedures used by a local manufacturer. "Maranhos" were prepared from raw ground adult goat meat mixed with rice and seasoned with salt, peppermint (*Mentha* sp.) and white wine. All the ingredients were then stuffed into natural casings, small bags especially made from the goat gastric compartments, and boiled for 75 minutes in a pan.
The water temperature and the temperature in the slowest heating point (SHP) of the product were measured during the cooking process with a CTF9008 Precision Digital Thermometer & F_0- Value Computer, ELLAB.
Samples of four uncooked and four cooked "Maranhos" were collected from each batch and immediately transported under cooling conditions to the laboratory.
Moisture content was determined by dissection until constant weight at 105ºC (Martins & Patarata, 1993). Ashes were determined by weighing the mineral residue after incineration at 550-600ºC (Martins & Patarata, 1993). Fat content was determined by the Soxhlet method (Martins & Patarata, 1993). Protein content was determined by the Kjeldhal method (Martins & Patarata, 1993). Carbohydrate content was estimated by exclusion of moisture, ashes, fat and protein contents. Energetic value was determined according to the classical conversion factors of Atwater (Martins & Patarata, 1993). pH was measured with a pH-meter HI9023-HANNA INSTRUMENTS. Water activity (a_w) was measured with the ROTRONIC HYGROSKOP DT, with the measure cell WA-14TH at 25ºC of constant temperature. Salt content was determined by the current method (NP-1845, 1982). Free fatty acids (FFA) were measured by extraction by chloroform and titration with 0.1N sodium hydroxide using phenolphthalein (Person, 1970). Peroxide value (PV) was determined by extraction by chloroform and titration with 0.01N sodium tiossulphat using starch as an indicator (Hungarian Standards, 1973). Tiobarbituric acid (TBA) was determined by spectrophotometer UV/Visible PHARMACIA BIOTEC Ultrospec®2000 with λ=538 nm (Martins & Patarata, 1993). Total basic volatile nitrogen (TVN) was determined by Conway cells method (Martins & Patarata, 1993).

For the microbiological analysis a 25 g sample of each sausage was aseptically transferred to a sterile plastic bag and pummelled in a stomacher LAB BLENDER-400 with 225 ml of buffered peptone water (DIFCO). Decimal dilutions of suspension were prepared using triptone salt solution (SCHARLAU) and plated in duplicate on different growth media. The following media and incubation conditions were used: total aerobic in Plate Count Agar (SCHARLAU) at 30ºC for 2 days; total psicrophiles counts in Plate Count agar (SCHARLAU) at 7ºC for 10 days; total anaerobes count in Anaerobic Agar acc. to Brewer (MERCK) inside an anaerobic jar at 7ºC for 10 days; total termophiles counts in Plate Count agar (SCHARLAU) at 42ºC for 2 days; moulds and yeasts counts in Cooke Rose Bengal agar with clorophenicol (OXOID) at 25ºC for 5 days; *Enterobacteriacea* counts in Violet Red Bile agar (OXOID) at 37ºC for 2 days; lactic acid bacteria counts on Man Rogosa Sharpe agar (OXOID) at 30ºC for 3 days; *E. coli* research with Kovacs reagent in Briliant Green broth (SCHARLAU) and Peptone water (DIFCO) at 45ºC for 2 days; *Clostrdium* sulphite reducers spoors research in Sulfadyzine Polimyxine Sulphite agar (MERCK) at 45ºC for 2 days; *S. aureus* research by the cuagulase test after isolation of suspicious colonies in Baird Parker agar (OXOID) and then Brain Heart Infusion (DIFCO) at 37ºC for 1day; *Salmonella* research by biochemical test API 20E (BIOMÉRIEUX) after isolation of suspicious colonies; and *Listeria monocytogenes* research by biochemical test API *Listeria* (BIOMÉRIEUX) after isolation of suspicious colonies.

Means of uncooked and cooked product were subjected to one-way ANOVA analysis of Statgraphics v. 7.0.

Results and discussion

Heat treatment is a critical operation, which takes part in most manufacturing processes of meat products, that controls not only microrganism growth but also affects taste, flavour, colour and texture of end products, allowing for sensorial features required by consumers (Botelho *et.al.,* 2003). The evolution of temperature values in SHP during the cooking process of the product is shown on the time/temperature chart (Fig. 1), the product reached temperatures above 90 °C for a range of time longer than 10 minutes, which are expected to cause a 6 log reduction of all vegetative pathogens present including spores of psychrotrophic *Clostridium botulinum*. However, heat resistant spores and pre-formed toxins may persist. That is, the heated product should be cooled as quickly as possible through temperatures that minimize the risk of spore germination and outgrowth. The cooling time will vary from product to product, but as a guideline, it should not exceed 4 hours (HMSO, 1993). Tables 1, 2, 3 and 4 summarise the results as mean, minimum and maximum values, standard deviation (SD), coefficient of percentage variation (CV%) and treatment significance (P) on the physicochemical and microbiological analyses.

Mean values for chemical composition of the uncooked product were the following: moisture 59.30%, protein 12.33%, fat 10.36%, carbohydrates 16.22% and ashes 1.79% and the mean energetic value was 871.25 kj/100g. Mean values for chemical composition of the cooked product were the following: moisture 60.58%, protein 14.08%, fat 7.50%, carbohydrates 16.50% and ashes 1.35% and the mean energetic value was 797.00 kj/100g. The differences observed between uncooked and cooked product in protein, fat and ash contents were very significant ($p<0.01$). The decrease in fat content could be explained by fat losses that occur during the cooking process, with a consequent increase in protein content in the centesimal composition of the cooked product. Fat melts at 37-40ºC, free fat may therefore escape from a product mixture at quite low temperatures unless held in an effective matrix (Ranken, 2000).

No significant differences between uncooked and cooked product were observed in the degradation indexes analysed. Mean values for uncooked and cooked product were: for FFA 3.67% and 3.85% as oleic acid, for PV 15.87 and 13.27 mequiv/kg of extracted fat, for TBA 0.28 and 0.37 mg of malonaldehyde/kg of analysed product and for TVN 25.91 and 21.81 mg/100g.

pH and a_w mean values were of 5.90 and 0.937 in the uncooked product and of 6.22 and 0.939 in the cooked product, which means that in both cases “Maranhos” is an easily perishable meat product. The differences observed in the pH value, which increased slightly after cooking, were very significant. A slight increase in the pH value is expected to happen when sodium salts are added to meat products because of their slight alkaline nature (Wirth, 1992). Highly significant differences in salt content were observed with a decrease from 1.07% in the uncooked product to 0.74% in the cooked one. These differences are due to salt diffusion into the water used to boil the product.

Highly significant differences were found in all the microbiological counts, and very significant differences for the *Enterobacteriacea* counts. The mean value for the aerobic plate count in the uncooked product was of 7.06 $\log_{10}$ cfu/g and after cooking the value decreased to 3.94 $\log_{10}$ cfu/g. Termophiles also reduced the accounts from an initial 4.34 to 2.93 $\log_{10}$ cfu/g, psicrophiles reduced from 7.05 to 2.93 $\log_{10}$ cfu/g, anaerobes reduced from 6.35 to 2.22 $\log_{10}$ cfu/g, moulds and yeasts reduced respectively from 2.24 and 4.92 to 1.11 and 2.24 $\log_{10}$ cfu/g, *Enterobacteriacea* reduces from 5.34 to 3.66 $\log_{10}$ cfu/g and the number of lactic acid bacteria reduced from 5.04 to 2.32 $\log_{10}$ cfu/g. *Staphylococcus aures* coagulase positive was present up to 0.1g in the cooked product. Research on the cooked product for *E.coli* and *Clostridium* sulphite reducers' spoors (absent in 1 g), and for *Salmonella* and *Listeria monocytogenes* (absent in 25 g) was always negative.

Conclusions

The ingredients hygienic quality is low therefore the raw product is heavily contaminated with vegetative microorganisms. Sometimes pathogens can be present. The shelf life of the raw product is very short and, therefore, it can be considered a dangerous product because it may be a source of cross contamination to other foods.

The heat processing of the product improves its hygienic standards and eliminates vegetative pathogens but not all spore forms. However, it cannot be overestimated because there is risk of recontamination during assembly that may present a food safety hazard. On the other hand, the heat treatment is probably too long, which results in fat losses and production yields.

Shelf life of the heat-processed product will depend on the control of all the above-mentioned factors. The growth of pathogenic flora can be controlled by product formulation, packaging systems and chill storage conditions. Modifications based on technology and combined preservative factors should be researched in order to develop a hurdle technology capable of preventing microbiological and chemical spoilage as well as the risk of food borne diseases to the consumer.

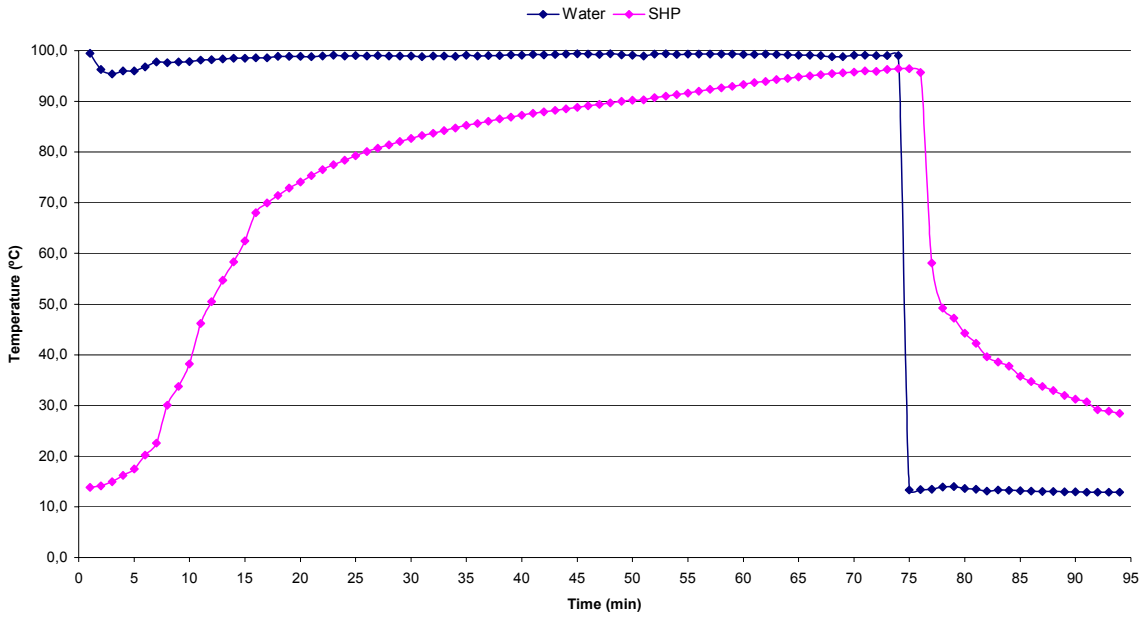

Figure 1. Temperature evolution in water and SHP of the product.

Table 1. Chemical composition**.**

	Uncooked					Cooked					
	Mean	Min	Max	SD	CV%	Mean	Min	Max	SD	CV%	P
Moisture (%)	59.30	47.69	64.51	4.79	8	60.58	56.01	64.93	2.52	4	n.s.
Protein (%)	12.33	10.53	14.94	1.04	8	14.08	11.10	16.15	1.45	10	**
Fat (%)	10.36	7.48	17.47	3.06	30	7.50	5.93	9.29	1.08	14	**
Carbohydrates (%)	16.22	12.72	22.06	2.87	18	16.50	12.96	20.73	1.90	12	n.s.
Ash (%)	1.79	1.37	2.51	0.34	19	1.35	1.03	1.75	0.23	17	**
Energetic value (kj/100g)	871.25	745.46	1210.68	138.54	16	797.00	696.66	904.68	57.32	7	n.s.

n.s.: not significant (p>0.05), *p<0.05, **p<0.01, ***p<0.001

Table 2. Degradation indexes**.**

	Uncooked					Cooked					
	Mean	Min	Max	SD	CV%	Mean	Min	Max	SD	CV%	P
FFA	3.67	1.59	7.93	2.11	58	3.85	1.26	8.66	2.38	62	n.s
PV	15.87	3.51	29.53	9.58	61	13.27	1.1	29.49	8.57	65	n.s
TBA	0.28	0.13	0.65	0.17	59	0.37	0.07	1.03	0.32	86	n.s
TVN	25.91	16.54	33.04	4.21	16	21.81	10.56	28.31	5.29	24	n.s

n.s.: not significant (p>0.05), *p<0.05, **p<0.01, ***p<0.001
FFA: % as oleic acid; PV: mequiv/kg of extracted fat; TBA: mg of malonaldehyde/kg; TVN: mg/100 g

Table 3. pH, aw and salt content**.**

	Uncooked					Cooked					
	Mean	Min	Max	SD	CV%	Mean	Min	Max	SD	CV%	P
pH	5.90	5.60	6.48	0.27	5	6.22	5.99	6.40	0.15	2	**
a_w	0.937	0.929	0.949	0.01	1	0.939	0.928	0.955	0.01	1	n.s.
NaCl (%)	1.07	0.81	1.44	0.19	18	0.74	0.46	1.09	0.19	26	***

n.s.: not significant (p>0.05), *p<0.05, **p<0.01, ***p<0.001

Table 4. Microbiological counts (log ufc/g).

	Uncooked					Cooked					
	Mean	Min	Max	SD	CV%	Mean	Min	Max	SD	CV%	P
Aerobic	7.06	6.41	7.57	0.33	5	3.94	2.66	4.79	0.69	18	***
Termophiles	4.34	3.70	4.85	0.34	8	2.93	1.98	4.09	0.58	20	***
Psicrophiles	7.05	6.62	7.51	0.25	4	3.59	2.09	4.72	0.82	23	***
Anaerobes	6.35	5.97	6.59	0.20	3	2.22	1.00	3.50	0.64	29	***
Moulds	2.24	1.00	2.94	0.61	27	1.11	1.00	2.00	0.28	25	***
Yeasts	4.92	4.23	5.60	0.43	9	2.24	1.00	4.53	1.13	50	***
Enterobacteracea	5.34	4.68	5.70	0.33	6	3.66	1.00	5.36	1.54	42	**
Lactic acid bacteria	5.04	3.63	6.18	0.87	17	2.32	1.00	4.58	1.19	51	***

n.s.: not significant (p>0.05), *p<0.05, **p<0.01, ***p<0.001

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