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Salting dynamics for anchovy (*Engraulis encrasicholus*) with salt replacers

R. Llorente Holgado, M. Altonaga Zubiaga, I. Peral Díez, I., M. Ibargüen Salaverri, and I. Gartzia Palacios

Food Research Division, AZTI Tecnalia, Txatxarramendi Ugartea, z/g, Sukarrieta 48395, Bizkaia-Spain. rllorente@suk.azti.es

Abstract

The salted anchovy (*Engraulis encrasicholus*) is a traditional heavy-salted food product in the Mediterranean countries with high nutritional value that contains approximately between 14 and 15 % of NaCl. However, changes in consumer life style motivate the tendency to reduce the amount of sodium chloride in food. The aim of the study was to compare and analyze the influence of salt replacers as a method to reduce the sodium content in salted anchovy. The texture and sensory properties and the penetration grade of sodium were studied during the ripening period. The results obtained showed that is it possible to develop a curing process with salts replacers for anchovy obtaining a reduction of 30-35% in the sodium content. From a sensorial and textural point of view, it is also possible to reduce the sodium content and obtain a product acceptable for consumers.

Keywords: anchovy, sodium content reduction, ripening, salt replacers.

1. Introduction

The salted anchovy (*Engraulis encrasicholus*) is a traditional heavy-salted food product in the Mediterranean countries with high nutritional value due to high content in polyunsaturated fatty acids that contains approximately between 14 and 15 % of NaCl. It shows a tender consistency and a specific pleasant aroma and taste as a result of the enzymatic activity on the fish flesh (Filsinger and cols, 1982).

Sodium chloride is an essential ingredient in the ripening anchovy process, contributing not only to the flavour and texture of this type of product but also to the microbiological stability (Pleps and cols, 2006)

However, changes in consumer life style, who are concerned about the harmful effects of a high level of sodium chloride in their diet, motivate the tendency to reduce the amount of sodium in food (Lynch, 1987). Nowadays, there are a number of approaches to reduce the sodium content in foods such as the use of salt substitutes in combination with masking agents, the use of flavour enhancers and the optimization of the physical form of salt (Phelps and al, 2006).

In recent years, several studies have demonstrated the possibility of salt reduction in meat products using different types of salt replacers as Potassium Lactate, Glycine and Potassium chloride in Fermented Sausages and Dry-cured Pork Loin (Gou and als, 1995) and Calcium Ascorbate in Fermented Sausages (Gimeno and als, 2001). However, few studies have been made in fish products, such us Fermented anchovy (Cha and al, 1989) and in ripened anchovy (Barceló and al, 2000).

Potassium chloride is probably the most common salt substitute used in low or reduced salt/sodium food. However, if it blends over 50:50 NaCl/KCl in solution, a significant increase in bitterness and loss of saltiness is observed (Desmond, 2006)

The aim of the study was to compare and analyze the influence of salt replacers versus NaCl in the textural and sensory properties during the ripening time of anchovy and the penetration grade of sodium.

2. Materials and Methods

Preparation of anchovy samples

Three different batches of ripened semi-preserved salted anchovies were prepared using two different salt replacers using NaCl as control (Co). The salt replacer number 1 (S1) containing a mixture of NaCl, KCl and Magnesium Carbonate and Sulphate and the second one (S2) containing mixture of ClNa, ClK, Maltodextrin, Potassium citrate, Magnesium Salts and Glutamic acid. Both of them were provided by a Spanish Food Ingredients company.

The salted anchovies (*Engraulis encrasicholus*) were prepared following the traditional method. The fish was caught off the Spanish Cantabrian coast and it was held in ice for at least 24h before arrival at the laboratory. Each fish was manually beheaded, partially gutted in the same operation and packed in cans. A layer of salt was first put in the container, then a layer of fish alternating until the container was filled with layers of salt and fish, finishing with a layer of salt. Cans were covered and pressed by means of heavy weights on top of the tap.

The salting experiments were carried out at 20ºC for 120 days, which is considered the time required in order to obtain commercial salted anchovy. Salted anchovy samples were taken for analyses at day 0, 7, 15 and 30 and after 2, 3 and 4 months.

Sensory quality

Sensory maturation evolution of the ripening process was assessed using the method developed by Filsinger and others (1982) and modificated by Pérez-Villarreal y Pozo (1992). Five trained panelists evaluated sensory quality. Six parameters were evaluated: flavour, flesh colour, odour, flesh texture, flesh adherence to backbone and saltiness perception. The average of the 5 panelists was taken as the score of the parameter. The maturation scale has its minimum at zero, representing sensory characteristics of raw fish, just before the beginning of the ripening process. Point 6 expressed the optimum level of ripening, and point 8 corresponded to spoiled or overripe anchovy. In case of saltiness perception, point 5 corresponded to very salty taste and point 1 corresponded to none salty taste.

Physicochemical analyses

Fish for physicochemical analysis were processed to remove external salt. After that, they were filleted, minced and analyzed in triplicate. The pH measurements were carried out using a digital pH-meter Crison GLP 21-22 by placing the electrode into the minced anchovy. Moisture was determined using the equipment Sartorius MA 100 and water activity (Aw) of the minced anchovy using the equipment Aqualab Serie 3. The chloride content was determined using the Volhard titration method (Ministerio de Sanidad y Consumo, 2004). Finally the Sodium and Potassium content was determined by atomic absorption spectrophotometry using a Perkin-Elmer model 5100 equipment.

Statistical analyses

All statistical analyses were performed using a one-way analysis of variance applying the LSD method using the Statgraphics Centurion XV software (STSC Inc., Rockville, USA) except for the sensory assessment where the Wilcoxon test was used. Significance of differences was defined at $p < 0.05$.

3. Results and Discussion

Physicochemical changes

The evolution of pH, water activity, moisture and the chloride content along the ripening process of anchovy can be observed in table 1.

After salting, the chloride content (0,32% in *Engraulis encrasicholus* fresh flesh, Hernández-Herrero et al, 1999) increased rapidly in anchovies during the first days of salting in all of batches. However, it can not be observed differences for moisture content and water activity. Only during the first week of ripening the increase and the posterior decrease in salt content were significant ($p<0,05$). A similar evolution has been reported by Srikar et al (1993). The highest chloride content at the end of the study was observed for S1 Batch, following Control Batch and finally S2 Batch.

Differences in chloride content could be explained by the different chemical composition of the three salts and granulometry.

During salting of anchovy with the three types of salt, the fish were surrounded by granular salt, which initially dissolved in the surface moisture of the fish. Sufficient salt was then available to go into solution and maintain the brine at saturation point as salt penetrated the fish and water was removed (Hernandez-Herrero and cols, 2002).

Regarding to pH in fish muscle, it remained constant for all groups during ripening time, obtaining higher values for anchovies which were ripened with S2 salt. The lowest pH value were obtained for Control batch. Differences in pH could be also explained by the different chemical composition of three salts.

		Days of ripening						
		0	7	14	29	60	90	120
Chloride content (%)	Co	17,14 (1,42)	17,57 (0,55)	16,95 (0,44)	18,42 (0,18)	17,36 (0,17)	19,41 (0,17)	19,44 (0,25)
	S1	19,91b (1,13)	20,52 (0,34)	18,84 (0,57)	18,96 (0,87)	18,39 (0,29)	18,59 (0,23)	20,92 (0,76)
	S2	16,87 (0,65)	18,27 (0,34)	16,16 (0,43)	16,82 (0,56)	16,05 (0,24)	16,49 (0,25)	16,70 (0,77)
Moisture (%)	Co	46,63 (1,20)	46,49 (0,48)	44,86 (0,20)	45,67 (0,27)	46,78 (0,62)	44,50 (1,20)	40,29 (0,29)
	S1	41,77 (1,74)	43,90 (0,51)	42,97 (0,19)	44,99 (0,49)	43,05 (0,92)	41,92 (0,61)	38,50 (0,48)
	S2	41,32 (1,14)	42,90 (0,38)	37,83 (0,36)	41,82 (0,53)	38,57 (0,49)	38,37 (0,50)	31,75 (0,38)
Aw	Co	0,742 (0,003)	0,740 (0,001)	0,740 (0,001)	0,734 (0,001)	0,724 (0,001)	0,726 (0,003)	0,719 (0,001)
	S1	0,718 (0,002)	0,708 (0,001)	0,713 (0,001)	0,711 (0,001)	0,700 (0,001)	0,701 (0,001)	0,697 (0,001)
	S2	0,716 (0,001)	0,703 (0,001)	0,704 (0,001)	0,702 (0,001)	0,690 (0,001)	0,693 (0,001)	0,693 (0,001)
pH	Co	5,60 (0,05)	5,49 (0,03)	5,20 (0,02)	5,18 (0,02)	5,83 (0,01)	5,81 (0,01)	5,53 (0,01)
	S1	5,80 (0,05)	5,67 (0,06)	5,51 (0,04)	5,56 (0,05)	6,05 (0,01)	6,02 (0,01)	5,84 (0,01)
	S2	6,01 (0,04)	6,00 (0,05)	5,89 (0,05)	5,76 (0,06)	6,71 (0,01)	6,12 (0,02)	6,41 (0,03)

Table 1: Changes in some physicochemical characteristics in the anchovy muscle during the ripening of salted anchovies. Co as control, S1 and S2 as salt replacers. Mean (Standard deviation) of triplicate.

When the moisture content and water activity were studied, both of them seemed to be constant during the maturing in all batches. However, it can be observed a lightly decrease in both parameters between the initial and final point of ripening. In contrast, Wheaton and Lawson (1985) reported a slightly increase in the moisture content during the later part of storage attributed to the absorption of brine by fish tissues. Similar to pH and chloride content, there are significant differences ($p<0,05$) in moisture content and water activity among the three batches. The S2 Batch had the lowest value for both parameters and the S1 batch the highest in moisture but no in water activity, where Control batch had the highest one.

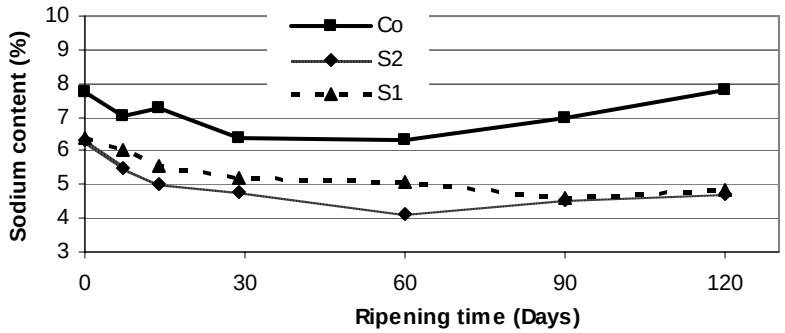

Fig. 1: Changes in sodium content during the ripening of salted anchovies. Co as control, S1 and S2 as salt replacers.

Regarding to the Sodium content (Fig. 1), the penetration grade of sodium throughout the ripening time of anchovies was lower in case of using S2 and S1 salts, being 30% less in sodium content at the end of the study. The main difference between salt replacers and the control was their high content in Potassium chloride and other compounds. At the end of the study, there were no significant differences ($p<0,05$) between both salt replacers in the sodium content of ripened anchovies. The sodium content was 4,70 and 4,83 % in anchovy muscle when S1 and S2 salts were used, respectively. However, the sodium content in anchovies cured only with NaCl (control) was up to 7,80%.

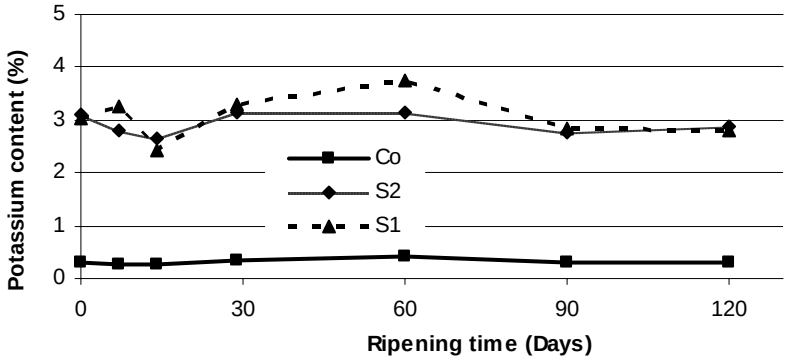

Figure 2: Changes in potassium content in the anchovy muscle during the ripening of salted anchovies. Co as control, S1 and S2 as salt replacers.

On the contrary, when the potassium content is studied (Fig. 2), the anchovies ripened with salt replacers showed a higher content in potassium. No significant differences ($p<0,05$) were found in the potassium content of anchovies for both salt replacers at the end of the study.

Sensory Assessment

In case of organoleptical parameters and more specifically the texture parameter (Fig 3), at 60 days, it was observed an overripe state of anchovies (8 points) when salts replacers were used (Fisinger and al, 1982). However, at the end of curing process, all of them showed the same textural properties and good panel acceptance.

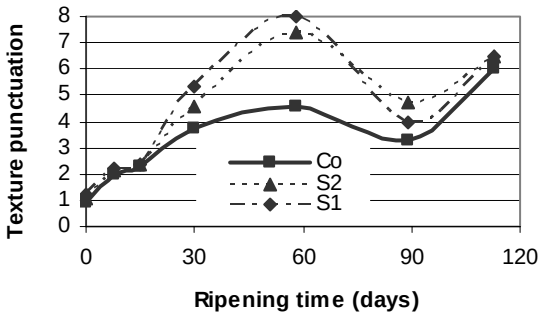

Figure 3 Texture punctuation by an expert panel along ripening time of anchovies using S2 and S1 as salt replacers.

In case of flesh adherence to backbone punctuation (Fig 4), at 30 days of ripening, all of batches reached 5 points. However while the behaviour of Co and S1 batches from this time to the end of ripening time was very similar, reaching 6 points at the end, the S2 batch become more adhered after this time. In spite of this increase in adherence for S2 batch, finally at 120 days of study it reached a ripe state similar to the other two batches.

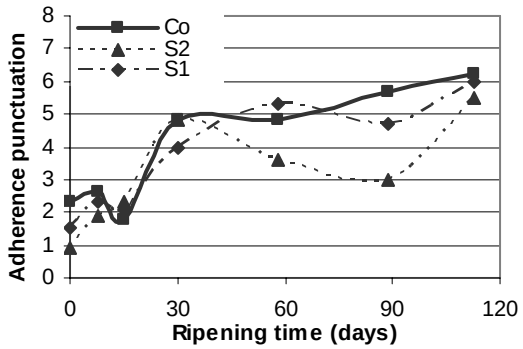

Figure 3 Flesh adherence to backbone punctuation by an expert panel along ripening time of anchovies using S2 and S1 as salt replacers.

Regarding to flavour and odour perception by panelists, no one did perceive any bitter taste in anchovies ripened with salts replacers. These results agree with those of Keeton (1984), who concluded that a substitution of NaCl for KCl of one-third is possible without significantly altering the product characteristics in country-style hams.

Although at 120 days, the odour and flavour in salt replacers batches had a lightly lower punctuation than the traditional salted anchovy, the anchovies could reach the ripen state in these parameters if their maturating time was increased in 15 or 25 days more. These results agree with those of Gou (1996) who demonstrated that a flavour improvement could also be obtained by mixing substitutes since, in mixtures of substances with different tastes, suppression of each taste tends to be the rule.

In contrast, when the saltiness perception was analyzed by the panelists, they perceived the anchovies ripened with salts replacers one point more salty than the control batch, although the salts replacers had lower sodium content than control one. It could be explained because some of their components enhance the flavour properties of foods without adding salt, as glutamic acid (Desmond, 2006)

4. Conclusion

These results indicate that it is possible to develop a ripening process with salts replacers for anchovy obtaining a reduction of 30-35% in the sodium content. From a sensorial and textural point of view, anchovies ripened with salt replacers show good organoleptical properties similar to the traditional ones. It can be concluded that these low salt content anchovies have a good quality and good acceptability by consumers.

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