P61: SODIUM CONTENT IN SPANISH-STYLE HALKIDIKI GREEN OLIVES AND ITS RELATIONSHIP WITH CONSUMER ACCEPTABILITY SCORES

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Abstract – Salt is a key component of table olive fermentation and preservation. Driven by the increasing demand for low-sodium table olives, this work aimed at investigating the effect of partial substitution of sodium chloride by other chloride salts on sodium content and the sensory profile of the Spanish-style PDO Prasines Elies Halkidikis. Partial replacement of sodium chloride in Spanish-style PDO product fermentation gave promising results not only for consumer acceptance but also for the microbiological safety of the new product.

Keywords: Halkidiki green olives; sodium content, sodium chloride, partial substitution, sensory attributes

1. INTRODUCTION

Table olives play an important role in the Mediterranean diet. In view of the demand for Mediterranean products, the world total table olive production and consumption is doubled over the last 16 years [1]. Specifically, Greece produces about 120,000 tonnes of table olives annually and is the second largest producer in the European Union. Approximately 40,000 tonnes are consumed in the domestic market, while the rest 80,000 tonnes are exported in 80 countries [2]. These figures show that table olives, one of the most representative Greek products, significantly contributes to the strengthening of the Greek economy. Among Greek varieties *cv*. 'Halkidiki' and 'Chondrolia Halkidikis' are two of the predominant varieties for table olive production. These varieties comprise 50% of the Greek production and 43% of the total amount of table olive exports [2]. Furthermore, "Prasines Elies Halkidikis" have obtained the recognition of trademark PDO (Protected Denomination of Origin). These large pale green oval olives are exclusively used in Spanish - style processing (Figure 1). This processing involves lye treatment using NaOH solution to debitter the olives, washing with water to remove the excess of alkali, brining and lactic acid fermentation [3].

Figure 1. Halkidiki Green Olives.

Use o of salt is a crucial parameter for table olive fermentation and preservation. In brined olives NaCl is involved in the nutrient extraction from fruits (osmotic exchange between fruits and brines) and in the pH decrease by increasing the ionic strength of the solution. These conditions transform brine into a suitable culture medium for the growth of selective microorganisms (lactic acid bacteria) and the inhibition of the pathogenic and spoilage microorganisms [4]. Appropriate pH and salinity values ensure the long shelf-life (1–2 years) of the fermented product. In the PDO product processing, the NaCl content of the fermentation and packaging brine is 8.5 and 6% (w/v), respectively. This results in high sodium content of olive flesh (1.4g/100g) [5].

The average salt intake worldwide exceeds the level of 5 g/day for the adult population and under 2 g/d for children recommended by the World Health Organisation (WHO) to a large degree (9 to 12 g salt/d for adults and more than 6 g salt/d in

children older than 5 years) [6, 7]. To achieve progress toward the global target to reduce intake of salt/sodium by 2025 by 30% consumer education is required. This is not a straightforward process since consumer sensory satisfaction is expected to affect the marketing success of the product [5]. This work aimed at investigating the effect of fermenting Spanish-style PDO Prasines Elies Halkidikis in brine with 50% substitution of NaCl by a mixture of other chloride salts on their sodium content and consumer acceptance.

2. EXPERIMENTAL

2.1. Olives and processing conditions

Green olives *cv.* Halkidiki and 'Chondrolia Halkidikis' were obtained directly from the industry (LADAS FOODS S.A, Halkidiki, Greece) after the debittering and washing steps and were fermented at lab-scale for 3 months according to the flow diagram shown in Figure 2.

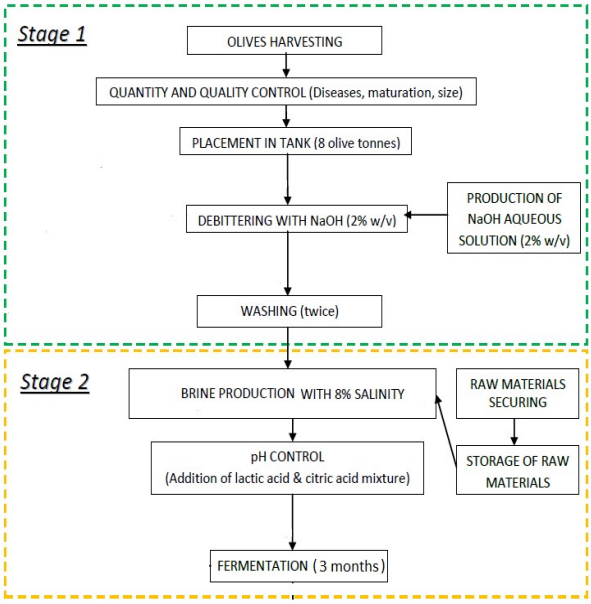

Figure 2. Production process of Halkidiki Green Olives

Olives were fermented in three brine solutions that differed in chloride salt composition but they had equal initial chloride ion concentration (8%, w/v). The brines were coded A, 100% NaCl (control); B and C, 50% substitution by different combinations of chloride salts. The initial pH value in all brines was ≤ 4.5.

2.2. Analysis of minerals in the flesh

Sodium content was determined in the olive flesh at the end of fermentation. For this purpose, the method described by [8] was used. For sodium, FAES technique (Flame Photometer Atomic Absorption B-LangeM6a type) was applied using appropriate radiation filter.

2.3. Sensory analysis

At the end of the three different fermentation processes, olives were evaluated by 40 consumers in the sensory testing room of LFCT. Sensory evaluation employed the descriptors related to the gustatory attributes (salty, acid, bitter), and others related to external appearance (surface color), aroma (typical flavor) and texture to classify the olives. Three olives were presented to each tester in a glass according to standard IOC/T.20/Doc. No5. Consumers should evaluate their acceptance on each attribute and overall acceptance of the three products using a 9-point scale. Point 1 of the scale referred to extremely dislike and point 9 referred to extremely like whereas the middle score, 5, was attributed to neither like nor dislike. Tap water was provided to consumers to rinse their palate before and between tasting. Mean values for each attribute (n=40) were used.

3. RESULTS AND DISCUSSION

The successful progress of lactic acid fermentation over a period of three months was monitored in terms of periodical measurements for microbial growth, pH, combined acidity, titratable acidity and reducing sugars (unpublished data).

3.1. Effect of initial brine composition on sodium content in fermented olive flesh samples

Data on the percent content of products B and C in Na with regard to that in A (Table 1) indicate that, indeed, it is worthy to try to reduce the sodium content in food products. Both treatments B and C can be regarded as successful. Nevertheless, it depends on the sensory acceptance of these products to which direction further efforts will continue.

Table 1 Percent content of sodium in fermented olives produced in modified brine solutions with reference to A (n=3)

Brine composition[a]	% of the sodium content of A[a]
A	100.0
B	30.3 ± 4.2
C	26.1 ± 3.4

[a] ***A*** *100% NaCl (control);* ***B*** *and* ***C*** *50% substitution by different combinations of chloride salts*

3.2. Effect of initial chloride salt concentration on sensory attributes of olives

No defects were detected by the consumers and the olives from all treatments were considered acceptable products. To study the relationship among consumers in scoring the descriptors for the three final products, the mean scores of all descriptors were calculated (Table 2).

Table 2. Sensory profile of fermented olives produced in different brine solutions
Different lowercase letters used as superscripts within the same row and for each sample indicate statistically significant difference $p < 0.05$.

Mean values for each attribute for olive samples produced using the three different brine solutions were similar and the small variations can be due to small differences in personal perceptions. Regarding saltiness scores the differences between the three products were not statistically significant and in favor of the fermented product in the brine solution (C).

Sensory attributes of table olives	Products after treatment		
	A	B	C
Color	7.5^{a}	7.3^{a}	7.6^{a}
Aroma	$7.0^{a,b}$	6.4^{a}	7.3^{b}
Taste	$6.6^{a,b}$	5.9^{a}	6.9^{b}
Texture	7.0^{a}	7.2^{a}	7.2^{a}
Acidic taste	5.7^{a}	5.9^{a}	6.2^{a}
Saltiness	6.1^{a}	6.1^{a}	6.4^{a}
Bitterness	5.8^{a}	5.4^{a}	5.5^{a}

4. CONCLUSIONS

Spanish style PDO Prasines Elies Halkidikis may be fermented in diverse chloride salt mixtures. The 50 % reduction in sodium chloride content in the initial brine led to the production of green table olives with lower sodium content by more than 60% compared to the PDO product. Despite this reduction the consumers did not find a significant difference in the 'saltiness' descriptor. Overall liking and scores for the other sensory descriptors (color, aroma, taste, texture, acidic taste, and bitterness) were in favor of the fermented olives produced in the modified brine solutions. Overall, partial replacement of sodium chloride in Spanish-style PDO product fermentation gave promising results for consumer acceptance. Microbiological safety of the new product upon storage, which determines product shelf life, a crucial parameter for industry, is currently under investigation.

ACKNOWLEDGMENTS

Authors thank LADAS FOODS S.A. company for providing the olive samples and access to its facilities

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