Reduction of salt in tomato products through the use of seawater

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Abstract

Reduced consumption of salt is associated with a reduced risk of cardiovascular diseases and is one of the most viable and cost-effective measures of improving public health on a global scale. Considerable research has been undertaken in the search for a viable alternative to common salt in the diet which maintains flavor without compromising organoleptic qualities. Sea water is one potential alternative, as, in comparison to common salt which is 100% sodium chloride, seawater contains only 86%, with the remaining 14% made up of a comprehensive and balanced range of minerals and trace elements. For this reason a variety of new tomato products have been developed which deliver reduced sodium levels, and higher nutritional quality.

Key words: tomato, reduction salt, seawater.

INTRODUCTION

One of the main contributing factors involved in incidences of primary hypertension (HTN) is the excessive consumption of sodium chloride (common salt). For every 2.5g of salt consumed 1g of sodium also enters the diet. World Health Organization guidelines recommend a maximum daily intake of 5mg of salt as a measure of preventing arterial hypertension. The salt that is currently used to enrich food and enhance its flavor is common salt, essentially composed of chlorine and sodium. The use of seawater for the production of tomato-based products will give these products a variety of advantages: reduction of common salt (the sodium found in seawater is in an ionic form also providing a balanced variety of trace minerals.), increase in nutritional value (from essential minerals which, enrich the food in the most complete, natural and, ultimately, healthiest way possible) and increased flavor (seawater enhances the natural flavor of all the components of the processed product). For this reason it can be said that, the use of seawater for the production of tomato-based products will improve both the nutritional and the organoleptic quality of the end products.

The benefits of seawater consumption are well documented in recent scientific literature. Some of these benefits are shown in Table 1.

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Table 1. Beneficial effects of sea water

Beneficial effects	**Individual**	Study
Decrease in serum cholesterol and the level of low density lipoprotein cholesterol	Humans	Chi, 2013
Decreased serum levels of total cholesterol, LDL-cholesterol and oxidative stress	Humans	Fu et al, 2011
Decreased cholesterol considered harmful (non-HDL cholesterol) and plasma triglycerides	Mice	Chang et al, 2012
Decrease in serum cholesterol and liver lipids	Rats	Shen et al, 2012
Decrease in total cholesterol, triglycerides, the atherogenic index	Hamsters	Hsu et al, 2011
Decrease in lipid levels in both serum and the liver.	Hamsters	Chen et al, 2013
Decreased LDL cholesterol	Rabbits	Miyamura et al, 2004
Prevention of cholesterol increase (total and HDL)	Rabbits	Yoshioka et al, 2003
Decrease in blood pressure and overall peripheral resistance	Rabbits	Katsuda et al, 2008
Modulation of blood pressure and display of hypolipidemic effects	Rats	Sheu et al, 2013
Cardioprotective effect	Mice	Shen eta al, 2013
Positive effect on the onset of atherosclerosis	Rabbits	Miyamura et al, 2004
Inhibition of platelet aggregation	Rabbits	Radhakrishnan et al, 2009
Decreased hyperglycemia and improved glucose tolerance	Mice	Ha et al, 2013
Decrease in glucose levels and improvement in tolerance tests	Mice	Hwang et al, 2009
Decreased obesity	Mice	Hwang et al, 2009
Reduced recovery time after exercise	Humans	Hou et al, 2013
Positive results on muscle damage produced by exercise	Humans	Hou et al, 2013
Improvement in physical performance	Hamsters	Wang et al, 2014
Improvement of mineral imbalance and symptoms in patients with eczema/dermatitis	Humans	Kimata et al, 2002; Hataguchi et al, 2005
Decreased cutaneous allergic response in patients with allergic rhinitis	Humans	Kimata et al, 2005
Improvement of the biomechanical properties of bone	Cellular culture	Linuma et al, 2004
Increase in bone mineral density	Mice	Liu et al, 2013
Effective in the treatment of mastitis as an antibiotic	Cattle	Solís et al, 2007

Upon searching for existing products made with sea water, two principal products were found: a seawater-based drink (ES-2251247_T3) and a seawater gelatin for therapeutic purposes made with agar-agar.(ES-2457093_B1)

In addition, several, other product patents were found in which seawater is used in their preparation:

- Craft beer: (http://www.aguademar.es/cerveza-er-boqueron)
- Potato chips: (http://www.aguademar.es/patatas-fritas-con-agua-de-mar)
- Bread: (http://www.aguademar.es/pan-con-agua-de-mar)
- Juice:(http://www.aguademar.es/zumos-con-agua-de-mar)
- Canned tomato: (http://www.aguademar.es/tomates-con-agua-de-mar)
- Stuffed olives: (http://www.aguademar.es/aceitunas-rellenas-con-agua-de-mar)
- Nuts: (http://www.aguademar.es/frutos-secos-con-agua-de-mar).

As can be seen, there is a significant body of scientific literature that attributes a variety of beneficial health properties to sea water. The integration of seawater into the diet through its incorporation into products that have been until now commonly prepared using salt, could significantly improve the quality of life of the consumer.

MATERIALS AND METHODS

Materials

The following materials were necessary for the completion of the trials:

- Treated seawater: obtained from a fixed point and several mobiles along the Mediterranean coast. Using pipelines suitable for food and pumping, the water is extracted from the sea (200 meters from the coastline) and transported by trucks to the holding tanks in the treatment plant where the water is filtered and purified mechanically without the use of chemical additives.
- Ingredients for the preparation of the sauces: water, tomato concentrate 28/30° Brix, sunflower oil, sugar, starch, onion powder, garlic powder, spices, diced tomato, tomato concentrate 28/30° Brix, olive oil virgin, tomato 12/14° Brix, smoke aroma, acetic acid, citric acid, xanthan gum, caramel coloring.
- Mixer, vacuum steam jacketed kettle, steam jacketed kettle, tin cans.

Methods

The work plan followed to carry out the study consists of 5 different parts, explained below:

1. Concentration of sea water

Firstly, the seawater was concentrated by means of a vacuum steam jacketed kettle, until it reached an acceptable concentration while maintaining the salts in solution.

2. Determination of sodium chloride content in concentrated and unconcentrated seawater

The salt concentration was analyzed using ICP chemical element analysis to determine Na, obtaining NaCl% through conversion by theoretical calculation.

The analysis was carried out using tables to correlate the Baumé degrees of NaCl% (www.iats.csic.es/datos/web/file/Salmueras%20Tablas.doc). Due to the concentration of the solutions, successive dilutions were necessary to reduce measuring errors.

Once the salt concentrations had been identified, theoretical calculation was carried out to establish the quantity of seawater to be added to the final products in amounts which replicate the quantity of salt that they normally contain.

3. Preparation of tomato sauces

A variety of tomato-based sauces were prepared (barbecue sauce, pizza sauce, fried tomato, homemade fried tomato) in which common salt was substituted with concentrated seawater or unconcentrated seawater, depending on the results of the sensory tests. The original tomato based products which contained common salt were also prepared as a reference.

For the preparation of the tomato sauces the following steps were followed: mixing of ingredients and blending with a mixer (in the case of fried tomato and barbecue), heating the mixture in a double-jacketed kettle to 90° C, then packed in tin cans and pasteurized for 40 min at boiling point.

4. Acceptance test

As with the development of all new food products the samples were subjected to sensorial testing. This was carried out by means of acceptance testing, which involves giving the appointed tasters the elaborated products coded with 3 random numbers. They are then given a tasting sheet (Figure 1) which has a scale in which various attributes are valued (appearance, color, taste, texture and acceptability) ranging from 1 (I dislike it very much) to 7 (I like it very much).

DATE:

NAME:

	SAMPLE CODE						
ASPECT	1	2	3	4	5	6	7
COLOR	1	2	3	4	5	6	7
FLAVOR	1	2	3	4	5	6	7
TEXTURE	1	2	3	4	5	6	7
ACCEPTANCE	1	2	3	4	5	6	7
OBSERVATIONS							

1: Dislike it very much
2: Dislike it quite bit
3: Dislike slightly
4: Neither like nor dislike it
5: Like it slightly
6: Like it quite bit
7: Like it very much

Figure 1. Sensory acceptance test card

5. Determination of salt content in water of the end products

Once the end products had been ranked sensorially, The salt concentration was then analyzed using ICP chemical element analysis to determine Na, obtaining NaCl% through conversion by theoretical calculation.

RESULTS AND DISCUSSION

Results

To begin with, concentrated seawater was elaborated by evaporating water in a vacuum steam jacketed kettle. This reached up to 16 ° Baumé, which corresponds theoretically, according to the previously mentioned conversion tables, with a concentration of 16.7% NaCl. Further concentration was not possible as the seawater solution became saturated and the salts precipitated. After that, the amount of concentrated seawater that was to be added to the new products was calculated theoretically such that the final salt concentrations were very similar to that of the original products.

The tomato based products were then elaborated with concentrated sea water and subjected to sensory analysis, adjusting the products to conform to the likes of the tasters by means of acceptability testing. The sensory tests returned the following results (Table 2).

Table 2. Products with concentrated seawater sensory acceptance test results

ATTRIBUTES	Fried tomato sauce with concentrated seawater	Homemade fried tomato sauce with concentrated seawater	Pizza sauce with concentrated seawater	Barbacue sauce with concentrated seawater
ASPECT	7.0	7.0	7.0	7.0
COLOR	6.8	6.9	6.7	6.9
FLAVOR	3.0	3.5	2.9	2.8
TEXTURE	6.7	6.8	6.9	6.8
ACCEPTANCE	3.0	3.2	2.8	2.7

Products were then prepared with non concentrated sea water and acceptability tests were carried out until a positive result was obtained. The results of the acceptability tests of these products are shown in Table 3.

Table 3. Products with seawater sensory acceptance test results

ATTRIBUTES	Fried tomato sauce with seawater	Homemade fried tomato sauce with seawater	Pizza sauce with seawater	Barbacue sauce with seawater
ASPECT	7	7	7	7
COLOR	6.7	6.9	6.8	6.9
FLAVOR	6.8	6.9	6.5	6.8
TEXTURE	6.8	6.9	6.9	6.8
ACCEPTANCE	6.8	6.9	6.8	6.9

Once the final products were obtained their salt content was analyzed. The original products were also analyzed in order to make a comparison between both. The results are shown in Table 4.

Table 4. % NaCl

Fried tomato sauce	2.33	**Fried tomato sauce with seawater**	1.60
Homemade fried tomato sauce	2.27	**Homemade fried tomato sauce with seawater**	1.50
Pizza sauce	1.84	**Pizza sauce with seawater**	1.18
Barbacue sauce	0.55	**Barbacue sauce with seawater**	2.84

Discussion

The maximum concentration of salt that can be reached in the elaboration of concentrated seawater will be 16.7% NaCl, due to the fact that at higher concentrations the solution becomes saturated and the salts precipitate.

Acceptance testing showed that the use of concentrated sea water for the development of tomato based products would not be possible, as it always required diluting. For that reason it was decided to continue trials using non concentrated seawater water.

The sensory analysis results shown in (Figure 2) demonstrate that in products made with concentrated seawater, the salt flavor is enhanced in excess of acceptable levels, requiring the addition of water in order to reduce the overly salty taste of the end product.

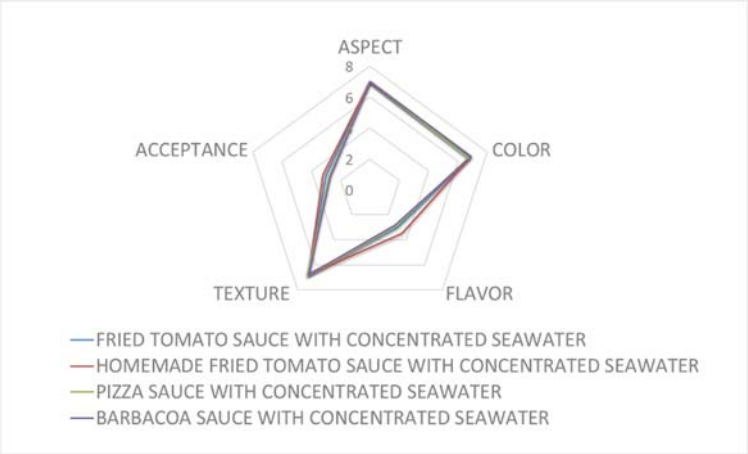

Figure 2. Spider chart products with concentrated seawater

As a result of these previous results, it was decided that subsequent trials would be conducted using non concentrated seawater. After successive trials and sensory analysis testing to determine the appropriate concentration of seawater, tomato based products were produced that were sensorially acceptable (Figure 3).

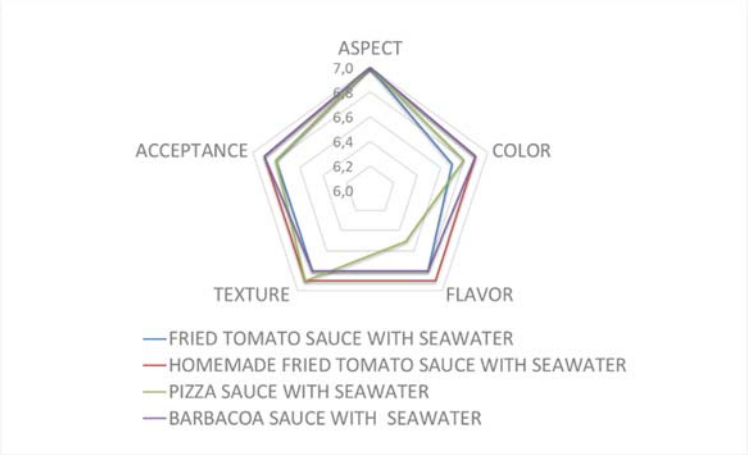

Figure 3. Spider chart products with seawater

The products that obtained an acceptable score were analyzed for NaCl %. The results show that the content of NaCl in fried tomato was reduced from 2.33% to 1.60%, and from 2.27% to 1.50% in homemade fried tomato.

For pizza sauce and barbecue sauce, however, the substitution of common salt was not possible as products made with sea water required a higher amount of NaCl in the trial product than in the original product.

CONCLUSION

Conclusion

The reduction of the amount of Na in fried tomato and homemade fried tomato is possible by replacing common salt with seawater in its preparation. The reduction was of 31.3% and 33.9%, respectively.

The reduction of NaCl in pizza sauce or barbecue sauce was not possible, as in order to reach a sensorially acceptable result, it was necessary to add a quantity of seawater which resulted in a higher NaCl concentration than products made with common salt as an ingredient.

According to data from Innova Market Insights, in the last three years, the food industry has launched 252,545 labelled as healthy products. The tomato based products that are the subject of this study fall into this category. Given its relationship with hypertension, cardiovascular disease, osteoporosis, kidney stones and gastric cancer, any reduction in Na content in food will also have a beneficial effect for society in general.

ACKNOWLEDGMENTS

This project received funding from the Junta de Extremadura, Program Decree 40/2016 for industrial research and experimental development projects for companies in the Autonomous Community of Extremadura. "Substitution of common salt in tomato derivatives with seawater to improve nutritional quality". EXP. AA-16-0139-1.

The authors would like to thank TOMALIA S.C.U.G. for their contribution as a project collaborator.

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