Nguyen Phuoc Minh et al /J. Pharm. Sci. & Res. Vol. 11(4), 2019, 1397-1400

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Effectiveness of Sugar Alcohol Replacement to Quality Characteristics of Dried Salted White Sardine during Storage

Nguyen Phuoc Minh[1,*], Tran Thi Yen Nhi[2], Thach Thi Hong Dao[3], Ly Phuoc Dien[4], Son Ngoc Bich[5]

[1]*Faculty of Chemical Engineering and Food Technology, Nguyen Tat Thanh University, Ho Chi Minh, Vietnam*
[2]*NTT Hi-Tech Institute, Nguyen Tat Thanh University, Ho Chi Minh City, Vietnam*
[3]*Mekong University, Vinh Long Province, Vietnam*
[4]*Tien Giang University, Tien Giang Province, Vietnam*
[5]*Can Tho University, Can Tho City, Vietnam*

Abstract.

White Sardine (*Escualosa thoracata*) is one of small pelagic fish which is mostly caught by fishermen. White sardine (*Escualosa thoracata*) enjoyed considerable economic importance in the traditional fishery. High local demand coupled with competitive price for the species might have led to overexploitation of this otherwise seasonal resource along the major areas of its abundance. Despite their domestic demand, they never received much attention from researchers due to highly seasonal nature of the fishery, low abundance and production. White sardine (*Escualosa thoracata*) is the one of the most important pelagic fish which become the fishermen's earn for living. In order to improve added value of white sardine, the present study focused on the production of dried salted white sardine with the replacement of sucrose by sugar alcohols (sorbitol, glycerol and xylytol). Results revealed that sugar alcohols were significicantly enhanced quality characteristics of the dried salted white sardine during storage for 12 months.

Keywords: *White sardine, sorbitol, glycerol, xilytol, sugar alcohol*

I. INTRODUCTION

White sardines are small pelagic fishes of the genus *Escualosa* under the family Clupeidae. Globally only two valid species *viz.*, the slender white sardine *Escualosa elongata* and the white sardine *Escualosa thoracata* have been documented. White sardine supports a seasonal fishery in the areas of their distribution along the coast. They are considered a delicacy especially among coastal community and fetch fairly high unit price. They generally form shoals in shallow waters of 5 to 30 m depth zone, preferably close to shore and are caught with encircling nets, particularly ring seines. Small quantity are also caught by gillnets, dolnets and trawls. Motorised and nonmechanised crafts are engaged in the fishery. Shoals of juveniles often enter backwaters and form minor fishery in drag nets, stake nets and cast nets (E. M. Abdussamad et al., 2018). The price of fish still may increase if we defend the quality, measure, and the weight of the fish (Bambang Setiono et al., 2014).

The sugar alcohols commonly found in foods are sorbitol, mannitol, xylitol, erythritol, isomalt, and hydrogenated starch hydrolysates. Sugar alcohols occur naturally and at one time, mannitol was obtained from natural sources. Today, they are often obtained by hydrogenation of sugars and other techniques. Sugar alcohols do not contribute to tooth decay. Sugar alcohol is neither a sugar nor an alcoholic beverage. They are white, water-soluble solids that can occur naturally or be produced industrially from sugars. They are used widely in the food industry as thickeners and sweeteners. In commercial foodstuffs, sugar alcohols are commonly used in place of table sugar (sucrose), often in combination with high intensity artificial sweeteners to counter the low sweetness. Xylitol is perhaps the most popular sugar alcohol due to its similarity to sucrose in visual appearance and sweetness (Awuchi Chinaza Godswill, 2017). Xylitol is a sugar alcohol used as a sweetener. Xylitol is categorized as a polyalcohol or sugar alcohol (alditol). It has the formula $CH_2OH(CHOH)_3CH_2OH$ and is an achiral isomer of pentane1,2,3,4,5-pentol. Unlike other natural or synthetic sweeteners, xylitol is actively beneficial for dental health by reducing caries (cavities) to a third in regular use and helpful to remineralization. Sorbitol, less commonly known as glucitol, is a sugar alcohol with a sweet taste which the human body metabolizes slowly. It can be obtained by reduction of glucose, changing the aldehyde group to a hydroxyl group. Most sorbitol is made from corn syrup, but it is also found in apples, pears, peaches, and prunes. It is converted to fructose by sorbitol-6-phosphate 2-dehydrogenase. Sorbitol is an isomer of mannitol, another sugar alcohol; the two differ only in the orientation of the hydroxyl group on carbon 2. While similar, the two sugar alcohols have very different sources in nature, melting points, and uses. Glycerol is the most common osmolyte in yeasts, but sugar alcohols such as D-arabitol, erythritol, and mannitol may also serve as osmolytes. The sugar alcohols produced may also have a role in redox balancing or as storage compounds (Awuchi Chinaza Godswill, 2017). In the osmotic dehydration of fish different agents such as salt, sugars, glycerol, and sorbitol have been used (Sanchez Pascua et al., 1994, 2001; Musjaffar & Sankat, 2006; Corzo & Bracho, 2007; Oladele & Ddedeji, 2008; Larrazabal-Fuentes et al., 2009; Czerner & Yeannes, 2010; Uribe et al., 2011). Lyoprotectants including saccharides, amino acids and sugar alcohols are used to stabilise the proteins during the freeze drying process (Arakawa et al. 2001; Shaviklo et al. 2011, 2012).

Lipid oxidation induces formation of an array of products directly or indirectly decreasing the sensory quality of fish and fish products (Jacobsen 1999). It produces unstable intermediary compounds such as free radicals and hydroperoxide precursors of volatile compounds

responsible for the development of off-flavors (Hsieh and Kinsella, 1989). The presence of highly unsaturated fatty acids in the dried product makes it difficult to maintain the lipid quality of fatty fish product during storage. There were several researches mentioned to the processing of white sardine. An attempt was made to investigate and explore a method for preparation of salted and dried white sardine which would have organoleptically sound attributes viz., color, flavor, taste and texture. It could, however, be concluded from the results of the present study that the sun dried pressed samples were in better condition than the unpressed sample (M.B. Priyadarshini et al., 2012). Influence of blanching treatment and drying methods on the drying characteristics and quality changes of dried sardine (*Sardinella gibbosa*) during storage was examined. Blanching treatment negatively affected the fish quality and is therefore not recommended for commercial sardine drying **(**O. O. Cyprian et al., 2017**).** Ojective of the present study focused on sugar alcohols (sorbitol, glycerol, xilytol) to the quality characteristics of dried salted white sardine during storage.

II. Materials And Method

2.1 Sample preparation

White sardine (*Escualosa thoracata)* fishes were collected from Phu Yen province, Vietnam. After collecting, they must be kept in ice chest below 4^{o}C and quickly transferred to laboratory for experiments. White sardine fishes were treated with different sugar alcohols (sorbitol, glycerol, xilytol) at 2.0% concentration, and sucrose 2.0% as control. All samples were treated with the same 3.0% salt, 0.1% monosodium glutamate, 1.0% garlic extract, 0.5% black pepper powder. Then all samples were dried by solar drying for 12 hours. The dried salted white sardine fishes were periodically sampled (0, 3, 6, 9 and 12 months) to verify quality characteristics during storage.

Figure 1. White sardine (*Escualosa thoracata)*

2.2 Physico-chemical evaluation

Water activity (a_w) was monitored using water activity meter. Texture (shear force, lb/in^2) was measured by penetrometer. Peroxide value (mEqO2/ kg) was determined using the CDR FoodLab® instrument. Thiobarbituric acid (mg maloaldehyde/ kg) was measured by 1,1,3,3-tetraethoxypropane (Torres-Arreola et al., 2007).

2.3 Statistical analysis

The experiments were run in triplicate with three different lots of samples. Data were subjected to analysis of variance (ANOVA) and mean comparison was carried out using Duncan's multiple range test (DMRT). Statistical analysis was performed by the Statgraphics Centurion XVI.

III. Result & Discussion

3.1 Physical changes of dried salted white sardine during storage by sugar alcohols (sorbitol, glycerol, xilytol)

Water activity (a_w) of dried salted white sardines during storage was shown in table 1. The control (sucrose) has a significant increase of water activity ($p<0.05$) during preservation. Meanwhile, dried salted fishes which were pre-treated with sugar alcohols (sorbitol, glycerol, xilytol) showed no increase throughout the storage process ($p\geq0.05$), indicating that the use of sugar alcohols delayed changes in water activity (aw) of dried salted fishes during storage.

Table 1. Water activity (a_w) of dried salted white sardines during storage by sugar alcohol replacements

Storage (months)	Sucrose	Sorbitol	Glycerol	Xilytol
0	0.45±0.01^{a}	0.45±0.01^{a}	0.45±0.01^{a}	0.45±0.01^{a}
3	0.48±0.03^{a}	0.46±0.02^{ab}	0.46±0.00^{ab}	0.45±0.03^{b}
6	0.50±0.01^{a}	0.46±0.03^{ab}	0.46±0.00^{ab}	0.45±0.02^{a}
9	0.53±0.02^{a}	0.47±0.00^{ab}	0.47±0.03^{ab}	0.46±0.00^{b}
12	0.57±0.01^{a}	0.48±0.01^{ab}	0.48±0.02^{ab}	0.47±0.03^{b}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 2. Texture (lb/in^2) changes of dried salted white sardines during storage by sugar alcohol replacements

Storage (months)	Sucrose	Sorbitol	Glycerol	Xilytol
0	14.48±0.02^{a}	14.48±0.02^{a}	14.48±0.02^{a}	14.48±0.02^{a}
3	14.27±0.02^{c}	14.45±0.01^{ab}	14.44±0.03^{b}	14.47±0.03^{a}
6	14.02±0.02^{c}	14.43±0.02^{ab}	14.42±0.02^{b}	14.45±0.03^{a}
9	13.90±0.03^{c}	14.38±0.00^{ab}	14.35±0.01^{b}	14.42±0.03^{a}
12	13.76±0.01^{c}	14.36±0.02^{ab}	14.32±0.00^{b}	14.37±0.03^{a}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 3. Peroxide value (mEqO2/ kg) changes of dried salted white sardines during storage by sugar alcohol replacements

Storage (months)	Sucrose	Sorbitol	Glycerol	Xilytol
0	0	0	0	0
3	0.47±0.02^{a}	0.11±0.00^{bc}	0.15±0.02^{b}	0.05±0.01^{c}
6	0.59±0.03^{a}	0.19±0.01^{bc}	0.21±0.01^{b}	0.08±0.00^{c}
9	0.74±0.01^{a}	0.21±0.03^{bc}	0.24±0.00^{b}	0.11±0.03^{c}
12	0.88±0.02^{a}	0.25±0.02^{bc}	0.31±0.02^{b}	0.13±0.00^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Table 4. Thiobarbituric acid (mg maloaldehyde/ kg) changes of dried salted white sardines during storage by sugar alcohol replacements

Storage (months)	Sucrose	Sorbitol	Glycerol	Xilytol
0	0	0	0	0
3	4.69 ± 0.03^{a}	1.06 ± 0.03^{bc}	1.38 ± 0.03^{b}	0.53 ± 0.02^{c}
6	5.73 ± 0.01^{a}	1.14 ± 0.01^{bc}	1.43 ± 0.00^{b}	0.64 ± 0.01^{c}
9	7.48 ± 0.02^{a}	1.22 ± 0.00^{bc}	1.54 ± 0.01^{b}	0.75 ± 0.00^{c}
12	8.94 ± 0.00^{a}	1.31 ± 0.01^{bc}	1.62 ± 0.03^{b}	0.82 ± 0.00^{c}

Note: the values were expressed as the mean of three repetitions; the same characters (denoted above), the difference between them was not significant (α = 5%).

Texture is an important quality factor in seafood which depends on species, age, size, fat, protein content, handling and storage conditions (Kagawa et al., 2002). Table 2 shows changes in texture of dried salted fishes during preservation. The control showed the highest loss of elasticity, while dried salted fishes treated with sugar alcohols had more elasticity probably due to the effect of sugar alcohols on lipids present in the muscle, thus delaying possible protein-lipid interactions, as has been documented by Torres-Arreola et al. (2007) that lipid oxidation in fish muscle can cause changes in texture due to the effect of protein-lipid interactions during dried salted storage. This protein-lipid interaction effect, together with a modification in the protein-water interactions and endogenous proteolytic activity of the muscle are the main factors that affect the integrity of the muscle fibers.

Atka mackerel (Am) and Japanese common squid (Sq) meats were cured in 0.5–1.5 M sorbitol solutions (pH 7.0) and dried at 30°C (relative humidity, 60%), and the effect of sorbitol on the moisture transportation and textural change during the curing and drying processes was investigated. With an increase in sorbitol permeated through samples, the moisture contents decreased by 52% (Am) and 42% (Sq) by curing in 1.5 M sorbitol solution. When the cured meats were dried, slow moisture vaporization occurred at the initial drying period, and the critical moisture content significantly decreased with an increase in the sorbitol content of the cured meats. Further, the hardening of the dried products was effectively suppressed by sorbitol curing. These effects of sorbitol would contribute to the reduction of drying time and particularly the elimination of the excess hardening of dried fish products (Zensuke Iseya et al., 2008).

3.2 Chemical changes of dried salted white sardine during storage by sugar alcohol replacements

White sardine are characterized by a high degree of unsaturation in the form of multiple double bonds in the fatty acids and are generally susceptible to molecular oxygen. Production of off-flavor compounds constitutes the primary quality deterioration observed during lipid oxidation, although the process of lipid oxidation can also lower nutritional quality and modify texture and color. From table 3, signifcant differences in peroxide value (mEqO2/ kg) of the three treatments applied during all stages of sampling were found ($p<0.05$), where the control showed the highest values compared to the dried salted fishes treated with and without sugar alcohols. Sugar alcohols could delay the formation of peroxides. Peroxides are intermediate metabolites during lipid oxidation in foods, so their formation increases up to a maximum value to later start decreasing encouraging the production of aldehydes and ketones as final oxidation products. Therefore the use of sugar alcohols significantly delayed the formation of peroxides.

Regarding to thiobarbituric acid (mg maloaldehyde/ kg), there was significant differences ($p<0.05$) among the three treatments executed (table 4). It was suggested that a marked lipid oxidation in the muscle occurred due to the high interaction with oxygen.

A study investigated the effects of replacing sucrose with sugar alcohols (sorbitol, glycerol and xylitol) on the quality properties of semi-dried jerky**.** Xylitol slightly decreased the pH when compared to the other sugar alcohols ($p>0.05$). The water activity of the semi-dried jerky was significantly reduced by treatment with glycerol and xylitol ($p<0.05$). The moisture content of semi-dried jerky containing various sugar alcohols was significantly higher than that of the control ($p<0.05$), while replacing sucrose with glycerol yielded the highest moisture content. The shear force of semi-dried jerky containing sugar alcohols was not significantly different for the sorbitol and glycerol treatments, but that replacing sucrose with 5.0% xylitol demonstrated the lowest shear force ($p<0.05$). The TBARS values of semi-dried jerkies with sugar alcohols were lower than the control ($p<0.05$). The sugar content of the semi-dried jerkies containing sorbitol and glycerol were lower than the control and xylitol treatment ($p<0.05$). In comparison with the control, the 5.0% xylitol treatment was found to be significantly different in the sensory evaluation ($p<0.05$). In conclusion, semi-dried jerky made by replacement with sugar alcohols improved the quality characteristics, while xylitol has applicability in manufacturing meat products (Sung-Jin Jang et al., 2015).

IV. CONCLUSION

The escalating concern of consumers towards the consumption of healthy food and leading a healthy lifestyle has encouraged the food industry to develop and market food products manufactured by considering the health aspect of the consumers. Health consciousness these days has become a trend. Fats, salt, and sugar no doubt are the principal ingredients in the majority of food preparations worldwide. They play a major role in flavor development and preservation. People desire to replace these ingredients without compromising the flavor and taste. The sugar alcohols commonly found in foods are sorbitol, mannitol, xylitol, isomalt, and hydrogenated starch hydrolysates. We have successfully investigated to study the effectiveness of sugar alcohols (sorbitol, glycerol, xilytol) to the dried salted white sardine quality during storage.

REFERENCES

1. Amir Reza Shaviklo (2015). Development of fish protein powder as an ingredient for food applications: a review. *J Food Sci Technol* 52(2): 648–661.
2. Arakawa T, Prestrelski SJ, Kenney WC, Carpenter JF (2001). Factors affecting short-term and long-term stabilities of proteins. *Adv Drug Deliv Rev* 46: 307–326.
3. Awuchi Chinaza Godswill (2017). Sugar alcohols: chemistry, production, health concerns and nutritional importance of mannitol, sorbitol, xylitol, and erythritol. *International Journal of Advanced Academic Research* 3(2): 31-66.
4. E. M. Abdussamad, K. G. Mini, R. Gireesh, D. Prakasan, T. B. Retheesh, Prathiba Rohit and A. Gopalakrishnan (2018). Systematics, fishery and biology of the white sardine *Escualosa thoracata* (Valenciennes, 1847) exploited off Kerala, south-west coast of India. *Indian J. Fish.* 65(1): 26-31.
5. Bambang Setiono, Sahri Muhammad, Diana Arfiati, and Daduk S. (2014). Fisheries bioeconomic analysis on white sardine *Escualosa thoracata* (Valenciennes) at Madura Strait, East Java, Indonesia. *J. Appl. Environ. Biol. Sci*. 4(8):1-8.
6. Corzo, D., Bracho, N., & Millán, R. (2008). Cambios de color en las láminas de sardina durante la deshidratación osmótica. *Revista Científca* 18(4): 424-430.
7. O. O. Cyprian, M. V. Nguyen, K. Sveinsdottir, T. Tomasson, G. Thorkelsson & S. Arason (2017). Influence of blanching treatment and drying methods on the drying characteristics and quality changes of dried sardine (*Sardinella gibbosa*) during storage. *Drying Technology* 35(4): 478-489.
8. Czerner, M., & Yeannes, M. I. (2010). Brining kinetics of different cuts of anchovy *(Engraulis anchoita). International Journal of Food Science & Technology* 45(10): 2001-2007.
9. Hsieh, R.J. and Kinsella, J.E. (1989). Oxidation of polyunsaturated fatty acids, mechanisms, products, and inhibition with emphasis on fish. *Adv. Food Nutr. Res.* 33: 233–341
10. Jacobsen, C. (1999). Sensory impact of lipid oxidation in a complex food systems. *Fett Lipid* 101: 484–492.
11. Kagawa, M., Matsumoto, M., Yoneda, C., Mitsuhashi, T., & Hatae, K. (2002). Changes in meat texture of three varieties of squid in the early stage of cold storage. *Fisheries Science* 68(4): 783-792.
12. Larrazabal-Fuentes, M. J., Escriche-Roberto, I., & Camacho-Vidal, M. M. (2009). Use of immersion and vacuum impregnation in marinated salmon (*Salmo salar*) production. *Journal of Food Processing and Preservation* 33(5): 635-650.
13. Musjaffar, S., & Sankat, C. K. (2006). The mathematical modelling of the osmotic dehydration of shark fillets at different brine temperatures. *International Journal of Food Science & Technology* 41(4): 405-416.
14. Oladele, A. K., & Ddedeji, J. D. (2008). Dsmotic dehydration of catfish (*Hemisynodontis membranaceus*): effect of temperature and time. *Pakistan Journal of Nutrition* 7(1): 57-61.
15. M.B. Priyadarshini, S. Sarkar, K.C. DoraS. Chowdhury and S. Ganguly (2012). Effect of pressing on the shelf life of sundried white sardine (*Escualosa thoracata*). Explor. *Anim. Med. Res.* 2(1): 39-44.
16. Sanchez Pascua, G. L., Casales, M. R., & Yeannes, M. I. (1994). Preliminary development of intermediate moisture, pasteurized chub mackerel (*Scomber japonicus marplatensis*) chunks. *Journal of the Science of Food and Agriculture* 64(2): 199-204.
17. Sanchez Pascua, G. L.S., Casales, M. R., & Yeannes, M. I. (2001). Influence of moisture and glycerol content on the aw of fish pastes. *Journal of Aquatic Food Product Technology* 10(1): 89-100.
18. Shaviklo GR (2011). Using product development approach for increasing fish consumption in the Near East region. *Infofish Int* 4:47–52.
19. Shaviklo AR (2012). Developing value-added products from lantern fish. *Infofish Int* 2: 42–46.
20. Sung-Jin Jang, Hyun-Wook Kim, Ko Eun Hwang, Dong Heon Song (2015). Effects of replacing sucrose with various sugar alcohols on quality properties of semi-dried jerky. *Korean Journal for Food Science of Animal Resources* 35(5): 622-629.
21. Torres-Arreola, W., Soto-Valdez, H., Peralta, E., Cardenas-López, J. L., & Ezquerra-Brauer, J. M. (2007). Effect of a low-density polyethylene film containing butylated hydroxytoluene on lipid oxidation and protein quality of Sierra fish (*Scomberomorus sierra*) muscle during dried salted storage. *Journal of Agricultural and Food Chemistry* 55(15): 6140-6146.
22. Uribe, E., Miranda, M., Vega-Galvez, A., Quispe, I., Claveria, R., & Di Scala, K. (2011). Mass transfer modelling during osmotic dehydration of jumbo squid (*Dosidicus jigas*): influence of temperature on diffusion coefficients and kinetic parameters. *Food Bioprocess Technology* 4(2): 320-326.
23. Zensuke Iseya, Tomokazu Kubo, Hiroki Saeki (2008). Effect of sorbitol on moisture transportation and textural change of fish and squid meats during curing and drying processes. *Fisheries Science* 66(6): 1144-1149.