Industria: Jurnal Teknologi dan Manajemen Agroindustri
Volume 9 Issue 1: 73-81 (2020)

Industria: Jurnal Teknologi dan Manajemen Agroindustri
http://www.industria.ub.ac.id
ISSN 2252-7877 (Print) ISSN 2548-3582 (Online)
https://doi.org/10.21776/ub.industria.2020.009.01.9

Quality Characteristics of Salt Fortification with Dragon Fruit Peel in Plastic Packaging during Storage Period

Iffan Maflahah*, Dian Farida Asfan
Department of Agro-industrial Technology, Faculty of Agriculture, Trunojoyo University
Jl. Raya Telang, Bangkalan 69162, Indonesia
*iffanmaflahah@gmail.com
Received: 04th April, 2019; 1st Revision: 30th October, 2019; 2nd Revision: 15th January, 2020; Accepted: 30th March, 2020

Abstract

Dragon fruit peel is another option for salt fortification beside of iodized salt. Dragon fruit peel contains source of vitamin C needed by our body. The objective of this study is to find out the quality characteristics of fortification of salt with dragon fruit peel during storage period. Fortified salt was stored in Low-Density Polyethylene (LDPE) and High-Density Polyethylene (HDPE) plastics at room temperature and at the temperature of 35 °C. Fortified salt was stored for a month. Tests performed during storage period were water content, NaCl, vitamin A and vitamin C content. The experimental design used was randomized block design with 2 factors, those are temperature and packaging type. Statistic test was performed with Variance Test and Duncan Test in the significance level of 5%. Fortified salt production used 40% of dragon fruit peel extract. Results showed that different packaging type and storage temperature did not have real impact on NaCl and vitamin A content of fortification salt with dragon fruit peel. Water content of fortification of salt with dragon fruit peel is affected by storage temperature. However, packaging type does not give real impacts on vitamin A content. Packaging type have a real impact on vitamin C content. Fortification of salt with dragon fruit peel has the ability to bind vitamin C so that it can be used as an alternative source of vitamin C.
Keywords: dragon fruit peel, salt fortification, storage

INTRODUCTION

Salt is the electrolyte source for our body (Purbani, 2000). Salt used is centered on three fields, those are food ingredients, industry (as a raw material and supportive material) and preservatives. Fortification is an addition of one or some nutrients to food. Fortification can prevent certain nutrient deficiencies, improve nutrient deficiency, return some substances that were exist in significant quantities but reduce as a result of the processing, increase nutritional quality of processed food products used as food source, ensure nutrient equivalency of the processed food that replaces other foods (Martianto, Marliyati, & Arafah, 2009). Food fortification is also used for eliminating and controlling nutrient deficiencies and any disorders it leads to (Siagian, 2003). Legal framework foundation of fortification process referred to Law Number 36 year 2009 on Health, Law Number. 18 year 2012 on Food, Presidential Decree Number 42 year 2013 on National Movement to Accelerate Nutrition Improvement, Government Regulation Number 28 year 2004 on Food Safety, Quality and Nutrition.

One example of fortified food is iodized salt. Iodized salt is used as an ingredient that can reduce iodine-deficiency disorders (IDD). Salt iodization is a common method used for processing salt. Fortification substances that are mostly include Potassium Iodide (KI) and Potassium Iodate (KIO_3). Iodate content of pure salt is more stable in the absorption process and bad environment condition (humidity). Also, it does not change salt color and taste (Howson, Kennedy, & Horwitz, 1998; Siagian, 2003). One of the methods of mitigating iodine deficiency is by the fortification of salt with iodine (Almatsier, 2013).

Currently, fortification of salt does not only use iodine, but also other ingredients that can be added to complete human nutritional needs. Another additional ingredient that can be used in fortification is soybean. Furthermore, it is known that the objective of fortification is to increase iron content in food product (Amin, Zulys, & Bakri, 2017). Seaweed (*Gracillaria sp.*) as iodine source that can be used as additional ingredients in food fortification (Rahayu, Astawan, &

Syarief, 2003).

Dragon fruit (*Hylocereus polyrhizus*) is a plant derived from dry tropical climate regions. This fruit is rich of antioxidant, such as vitamin C, flavonoid and polyphenol compounds. Dragon fruit peel is often considered as waste rather than as a useful ingredients. Dragon fruit peel is a natural antioxidant (Wu et al., 2006; Stintzing, Schieber, & Carle, 2002), from 1 mg/ml of red dragon fruit peel can inhibit 83.48±5.03% of free radical. Meanwhile, dragon fruit flesh can only inhibit 27.45±1.02% of free radical (Nurliyana, Zahir, Suleiman, 'Aisyah, & Rahim, 2010). One hundred gram of red dragon fruit flesh contains 60 kcal of calories, 0.53 g of protein, 11.5 g of carbohydrate, 0.71 g of fiber, 134.5 mg of calcium, 87 mg of phosphor, 0.65 mg of iron, 9.4 mg of vitamin C, anthocyanin, antioxidant, phenol, flavonoid, protein, fat, water, carbohydrate, ash and 90% of water content (Handayani & Rahmawati, 2012; Noor, Yufita & Zulfalina, 2016). Those advantages are the facts which then underlies the use of dragon fruit peel as one of the ingredients of food fortification.

Food product packaging aims to keep and protect the food so that its quality and safety can be preserved (Hui, 2006). Fortification of salt with dragon fruit peel is wrapped in plastic packaging made from *Poly Ethylene* (PE). There are two types of PE plastic, those are LDPE (*Low Density Poly Ethylene*). Both plastic packaging types are commonly used in food products. Plastic as a packaging material is more favorable than other materials as it is lightweight, transparent, strong, thermoplastic and selective in its permeability against water vapor, O_2 and CO_2. Plastic permeability against water vapor and air enables this material to modify packaging space during storage period (Winarno, 2004).

Salt has hygroscopic characteristics. For this reason, proper packaging type must be used to keep salt quality. Quality parameter that will be used to define proper packaging type was SNI 01-3566-2010 of salt for consumption (SNI 3556:2010. Salt for Consumption - Iodine, 2010). Parameter referred is H_2O and NaCl content. Meanwhile, vitamin A and vitamin C content were used as the parameter of salt content added with dragon fruit peel, as this ingredient is rich of vitamin A and vitamin C.

The objective of this research was to figure out quality content of fortification of salt with dragon fruit for 1 (one) month stored at room temperature and at the temperature of 35 °C using LDPE and HDPE plastic packaging.

METHODS

This research was performed in Agricultural Industry Technology Laboratories, Faculty of Agriculture, Universitas Trunojoyo Madura. The ingredients used here were sea salt, dragon fruit peel, LDPE and HDPE plastic package and incubator. Research method used was randomized block design with 2 factors, temperature and packaging type. Statistic testing was conducted using Analysis of Variance test (ANOVA) and continued with Duncan's Test at 5% significance level.

Research process was initiated with the preparation of dragon fruit peel extract. The next step was the preparation of fortification of salt with dragon fruit peel. That salt was wrapped using LDPE and HDPE plastic package. Each packaging was filled with 100 grams of fortification of salt with dragon fruit peel. Storage process was performed at room temperature and at the temperature of 35 °C for 1 month. At room temperature, salt was placed in an open place, while at the temperature of 35 °C, salt was placed inside the incubator by the addition of some adjusted lamp and its temperature was kept consistent. During 1 month of storage process, fortification of salt with dragon fruit peel was placed at the determined temperature and packaged in day 0, 7, 14, 21 and 29. The observation was performed in the parameter of NaCl content, water content, vitamin A and vitamin C.

Preparation Process of Fortification of Salt with Dragon Fruit Peel

Preparation process of salt fortification with dragon fruit peel was begun with dissolving sea salt in the comparison of 350 grams in 1 liter of distilled water (be = 20) and boiling it until all of the water evaporated. Dragon fruit peel extract used was 25 grams in 500 ml of distilled water. The addition of dragon fruit peel extract is as many as 40%. The next step was drying process by using heating technique aiming to reduce the water content (Permatasari, Helmiyati, & Iskandar, 2017).

Water Content Test

Water content test was performed by using oven (AOAC, 1984). Water content was calculated on weight-percent basis, which means that sample weight divided by the weight difference of the sample that had not been evaporated with the sample that had been dried. The work order was performed as follows:

- Porcelain cup and its lid were cleaned and dried in the oven at the temperature of 105 – 110 °C for 1 hour. After that, it was cooled in the desiccator for 30 minutes and its weight was measured (A).
- 2 grams of samples were measured and placed in a porcelain cup that had been measured before (B). Samples in the porcelain were dried at the temperature of 105 °C for 3 hours and then cooled in the desiccator for around 15 minutes and its weight was measured (C).
- The measurement was repeated until the weight obtained was constant.

$$Water\ content = \frac{(B-C)}{(B-A)} x100$$

NaCl Content Test

NaCl content was calculated by using the principle of Mohr Method (Day & Underwood, 1996). Basically, dry samples resulted from evaporation process can be titrated with nitrite silver. Ion - silver ions will form chloride silver sediments until chloride ions had run out and the excessive silver was measured by potassium chromate.

Basically, samples were measured as many as 5 g and turned into ash. Ash was washed with the distilled water as little as possible and moved into 250 ml Erlenmeyer, then added 1 ml of 5% potassium chromate solution and titrated with 0.1 M silver solution. End point of the titration was achieved when the first cloudy red color arouse. Salt content can be measured using the formulation of:

$$\%\ Nacl = \frac{T\ x\ M\ x\ 5{,}84}{W}$$

T= titer
M = silver nitrate molarity
w = sample's weight

Vitamin A Test

Vitamin A testing was carried out by using spectrophotometer, where the samples were put into the test tube and the chloroform was added dropwise until it dissolved. Then 2 drops of acetic anhydride were added (to remove water and $SbCl$ solution$_3$. Maximum wavelength used were 325 nm up to 328 nm (AOAC, 1984).

Vitamin C Test

Vitamin C was tested by these following steps (AOAC, 1984):

1. Preparation of vitamin C standard solution

The ingredients were measured, 50 mg of vitamin C were dissolved in 6% metaphosphoric acids in 100 ml volumetric flask. Metaphosphoric acids 6% were added until the full volume was reached. Then, 4 ml of the solution was then diluted until 50 ml with metaphosphoric acid solution 6%. From this solution, the standard solutions were made by the concentration of 1, 2, 4, 6, 8 and 10 bpj.

2. Defining maximum wavelength

Two mililiters of raw vitamin C solution was taken using pipette and diluted with 6% of phosphoric acid as many as 10 ml. Then, 5 ml of the solution was taken using pipette and added quickly with the reactant of 2.6 dichlorophenol indophenol. The mixture was then shaken and quickly measured at the wavelength of 480-530 nm.

3. Preparation of Sample Solutions

One gram of jam, 1 gram of candied fruit, and 1 gram of juice were added with 5 ml of 6% metaphosphoric acids each and then mixed to be homogenous solutions and filtered. The filtered solution was added with 6% metaphosphoric acids so that the volume was 10 ml. Each solution was taken using pipette for around 1 ml and put in 10 ml volumetric flask. It was added with 6% metaphosphoric acids solutions until the full volume was reached.

4. Vitamin C Measurement

One mililiter of sample solutions were taken using pipette and added quickly with the reactant of 2.6 dichlorophenol indophenol. Its absorption was then measured in spectrophotometer.

RESULTS AND DISCUSSION

Salt fortification with dragon fruit peel was packaged with LDPE plastic. The packaging was stored at the room temperature and at the temperature of 35 °C. Parameter measurement referred to consumption salt quality requirements according to SNI 01-3556-2010 (Table 1). In the salt fortification with dragon fruit peel process, there was no iodine content test as this fortification did not add any iodine.

The characterization of fortification salt was figured out by conducting water content, NaCl content, Vitamin A, and Vitamin C test. This

Table 1. The requirements of consumption salt quality according SNI 01-3556-2010

No	Test Criteria	Unit	Requirements
1	Water Content (H_2O)	% (b/b)	Maximum 7
2	NaCl content (sodium chloride) was calculated from chloride amount (Cl)	% (b/b) dwb	Minimum 94.7
3	Iodine is calculated as potassium iodate (KIO_3)	% (b/b) dwb	Minimum 30.0 ppm
4	Insoluble in water	mg/kg	Max 0,5
5	Metal contamination		
	- Lead (Pb)	mg/kg	Maximum 10.0
	- Copper (Cu)	mg/kg	Maximum 10.0
	- Mercury (Hg)	mg/kg	Maximum 0.1
6	Arsenic contamination	mg/kg	Maximum 0.1

Description: b/b = weight/weight; dwb = dry weight basis

Table 2. Initial characteristic of fortification of salt with dragon fruit peel

No	Testing Criteria	Content
1	Water Content (H_2O)	0.79 %
2	NaCl Content	92.95 %
3	Vitamin A	4.09 mg
4	Vitamin C	4.05 mg

Description: b/b = weight/weight; dwb = dry weight basis
Source: Result of analysis

Table 3. The average water content and NaCl content of fortification salt with dragon fruit peel during storage period in LDPE plastic

Duration of Storage	Water Content (% (b/b))				NaCl Content (% (b/b))			
	LDPE Packaging		HDPE Packaging		LDPE Packaging		HDPE Packaging	
	A	B	A	B	A	B	A	B
Week 0	0.79 b	0.79 b	0.79 b	0.79 b	92.95	92.95	92.95	92.95
Week 1	0.79 a	0.79 a	0.76 a	0.75 a	92.95	97.63	85.18	80.75
Week 2	0.76 a	0.85 a	0.81 a	0.71 a	91.2	96.46	82.84	78.74
Week 3	0.6 b	1.83 b	0.94 b	1.85 b	90.03	94.71	80.51	78.45
Week 4	0.7 b	1.93 b	1.28 b	2.06 b	88.78	90	80,2	78.15

Description: A = room temperature; B = temperature of 35 °C.
a and b were used to show a real different value

kind of test was performed to find out the initial characteristic of the tested fortified salt so that the hypothesis of any damage possibility, either physical, chemical or microbial damages during storage period, can be predicted. Result of characterization of fortification of salt with dragon fruit peel can be seen in Table 2.

Based on the result of fortified salt characterization, water content obtained was 0.79%. Water content in SNI of salt for consumption is 7% at most, so that the water content meets the requirements. However, NaCl content obtained was 92.95% and in SNI of salt for consumption was at least 94.7%. NaCl content determines salty taste of salt. Salty taste was affected by NaCl concentration of the salt granules. The result of salt fortification was still under SNI standard. Different NaCl content was caused by the different salinity of each location's seawater. Any factors influencing salinity were different intensity of sunlight, temperature, humidity, rainfall, fresh water contribution from land and so on (Zainuri, Anam, & Susanti, 2016).

Vitamin C content in fresh dragon fruit peel was 9.4 mg (Handayani & Rahmawati, 2012). When it was added to salt and became fortified salt, vitamin C content changed into 4.05 mg. Vitamin C decrease was caused by the heating process in the salt preparation.

The average of water content, NaCl, vitamin A and vitamin C of salt fortification with dragon fruit peel during storage period using LDPE plastic can be seen in Table 3 and Table 4 for HDPE plastic.

Table 4. The average of water content and NaCl Content of fortification of salt with dragon fruit peel during storage period in HDPE plastic packaging

Duration of Storage	Vitamin A (mg)				Vitamin C (mg)			
	LDPE Packaging		HDPE Packaging		LDPE Packaging		HDPE Packaging	
	A	B	A	B	A	B	A	B
Week 0	4.09	4.09	4.09	4.059	3.61 a	3.61 a	3.61 a	3.61 a
Week 1	4.09	4.07	4.07	4.05	3.61 a	3.26 bc	3.60 bc	3.5 bc
Week 2	4.18	4.36	4.03	4.01	2.29 ac	2.02 ac	3.57 ac	3.28 ac
Week 3	4.2	4.35	4.01	4.00	2.3 a	2.00 a	3.55 a	3.02 a
Week 4	4.1	4.11	4	3.85	2.3 ab	2.00 ab	3.3 ab	2.92 ab

Description: A = room temperature; B = temperature of 35ºC
a, b and c showed that the value is extremely different

Water Content

Water content refers to the amount of water contained in a certain food and it is expressed in the form of percentage. Water content is also a crucial parameter in defining food quality as water can affect the appearance, texture and taste of the food. Water content in a certain food is also determining food freshness and preservation. High water content causes bacteria, mold and yeast reproducing easily which can lead to changing quality of food product. (Dwidjoseputro, 2005). Water content will affect product's storability, clotting time of powder product, stability against microbiological contaminant, product's flow ability, total dry solids, concentration or purity, conformity with the agreement, nutrition value and conformity with government regulation.

Result of statistical test in Table 3 showed that storage temperature have a real impact ($p<0.05$) on salt water content that is p value of 0.03. Water content in week 0 and week 5 were quite different with week 1 and week 2. Additionally, water content in week 2 was quite different with week 3. The treatment of packaging type did not have real impact on salt water content ($p>0.05$).

Water content in fortification of salt with dragon fruit peel at the room temperature using LDPE packaging during first week was 0.79% and it decreased to 0.7% in the fourth week. Similarly, this also occurred at the temperature of 35 °C, which showed that the water content of first week was 0.22% and 1.93% in the fourth week.

Water content of salt fortification in HDPE and LDPE packaging did not show any differences. At room temperature, water content increased from 0.79% to 1.28%. Water content at the storage temperature of 35 °C increased from 0.72% to 2.06%. Water content changes were affected by temperature increase of the product in the package. Permeability value of plastic packaging can be affected by the characteristic of the packaged ingredients, temperature and environment's relative humidity. Using the same plastic type in a different storage will affect different permeability so that the respiration speed of the package will be affected. (Siracusa, 2012).

Water content change of the product was affected by permeability of the packaging material, environment humidity and hygroscopic of salt fortification that the product was able to absorb environment water through packaging material and it led to an increase in water content (Wijaya, Yuliasih, & Sugiarto, 2007).

In this fortification of salt, the packaging used was LDPE plastic which has high resistance so that it can endure external impact. Some aspects which cause increasing water content of fortified salt did not significantly change.

Water content increase occurred even when the salt was stored in the plastic. According to Permatasari et al. (2017), food stored in waterproof plastic packaging can be deteriorated due to the increased water content. This is due to the raw material of the plastic, polyethylene, which has good permeability for *humid air turning over*. This explained the decrease after the measurement of day 7 up to day 21. Meanwhile, water content in HDPE packaging increases, especially at the storage temperature of 35 °C. According to Hui (2006), the density of LDPE was ranging from 0.915 until 0.939 g/cm^3. However, the density of HDPE was above 0.940 g/cm3. Density can indicate plastic's ability to protect the product from some substances, such as water, O_2 and CO_2. Low density plastic shows that it has open structure which means that certain fluids like water, oxygen or CO_2 can permeate this plastic. The use of plastic packaging can protect the product from water vapor or gas (Siracusa, 2012).

NaCl Content

NaCl content was one of the standard of salt quality. Based on the statistic test in Table 3, it is showed that storage temperature treatment and packaging type did not have real impact ($p>0.05$) on the NaCl content of fortification of salt with dragon fruit peel. The p value on the impact of packaging type on the NaCl content was 0.943 and the impact of storage temperature on NaCl content was 1.

NaCl content in fortification of salt with dragon fruit peel in LDPE packaging at the room temperature for the first week was 92.95%, the second week was 91.2% and the fourth week was 88.78%. Meanwhile on storage process at the temperature of 35°C in the first week was 97.63% and in the fourth week was 90%. That condition was equal to the use of HDPE plastic packaging. Salt fortification with dragon fruit peel during storage both at the room temperature and at the temperature of 35 °C decreased significantly.

Packaging type cannot increase NaCl content as NaCl content can only increase in the production process. To increase NaCl content, fortified salt preparation technology should be changed.

In order to achieve standard NaCl content, advanced processing was needed in the salt production. The processing stage can be carried out using deposition techniques for the sake of purification process (Widayat, 2009; Sulistyaningsih, Sugiyo & Sedyawati, 2010).

NaCl content of fortification of salt has not met SNI requirements of table salt. NaCl content is affected by the sea location as the raw material of salt. One of the ways of improving salt quality is by recrystallization process (Davis, 2013; Masero, 2003). Recrystallization is a method of salt purification by dissolving salt in hot water and re-evaporating it.

Recrystallization process can use natural zeolite as impurity binder that works effectively in the purification of table salt. NaCl content of salt produced from the crystallization of zeolite and 0.1 M HCl solutions was 98.73% (Jumaeri, Sulistyaningsih, & Sunarto, 2017). Meanwhile Nurhidayati (2007) stated that to meet the requirements of pharmaceutical salt, table salt needs to be purified by four times recrystallization.

Research performed by (Maulana, Jamil, Putra, Rohmawati, & Rahmawati, 2019) mentioned that before evaporation process, salt solution of *bledug kuwu* needs to be added with impurity binder ingredients so that the impurity ions can be separated from salt, and salt will be purified. In line with the statement of Gemati, Gunawan, & Khabibi (2013), impurity of table salt can be reduced by adding impurity binder ingredients such as Na_2CO_3, NaOH and Polyaluminium Chloride. Meanwhile, Broto & Kusumayanti (2007) mentioned that table salt with 95% of NaCl content can be produced by using washing method.

Vitamin A

Dragon fruit peel is rich of vitamin A. The chemical content of dragon fruit and dragon fruit peel are including flavonoid (Hilal, Handayani, & Atun, 2010) vitamin A, C, E and polyphenol (Siregar et al, 2011). Statistical result in Table 4 showed that storage temperature treatment and packaging type do not have real impact ($p>0.05$) on the vitamin A content of salt fortification with dragon fruit peel. The p value in the impact of packaging type on the vitamin A content was 0.115 and the impact of storage temperature on vitamin A content was 0.521. Vitamin A content during storage period at the room temperature in LDPE and HDPE plastic packaging ranging from 4.09 - 4.10 mg. Similarly, at the temperature storage of 35 °C the temperature was ranging from 4.07 - 4.11 mg.

The addition of dragon fruit peel in the process of salt production was expected to bring antioxidant content. Dragon fruit peel is the source of natural antioxidant (Stintzing et al., 2002; Wu et al., 2006)). Antioxidant is a substance which can protect cell to defeat any damages caused by free radical (*Reactive Oxygen Species*). Natural antioxidant can increase resistance of oxidative damages, as a substance that influence human health. In food products, antioxidant can be used to prevent oxidation process that will lead to any damages, such as rancidity, color and smell changes as well as other physical changes. Antioxidant can be found in the form of nutrient, such as vitamin E and C, non-nutrients (carotene pigment, lycopene, flavonoid and chlorophyll), and enzyme (glutathione peroxidase, co-enzyme Q10 or ubiquinone). Antioxidant can be categorized into 3 (three) groups, those are preventive antioxidant (superoxide dismutase, catalase and glutathione peroxidase enzyme), primary antioxidant (vitamin A, phenolate, flavonoid, catechin, quercetin) and complementary antioxidant (vitamin C, β-carotene, retinoid) (Shalaby & Shanab, 2013). Based on the result of this research, fortification of salt with dragon fruit peel can be considered as an alternative for food source containing antioxidant that during storage period, its nutritional value does not change.

The result of statistical test in Table 4 indicated that storage temperature treatment did not have real impact ($p>0.05$) on the vitamin C content of salt fortification with dragon fruit peel. The p value in the packaging type impact on the vitamin C content was 0.078. The packaging type had a real impact on the vitamin C content ($p>0.05$). Vitamin C content in salt fortification with dragon fruit peel in LDPE and HDPE plastic at room temperature and the temperature of 35 °C was different each day. Dragon fruit peel has high vitamin C content that is 9.4 mg (Handayani & Rahmawati, 2012). In the beginning of the research, vitamin C content of fortification salt with dragon fruit peel was 4.05 mg and during storage period at room temperature, this content decreased significantly where in the first week it became 3.61 mg and in the fourth week it became 2.30 mg. Similar to LDPE plastic, salt product packaged in HDPE plastic was also changing. At the room temperature, it decreased from 4.05 mg to 3.30 mg. Meanwhile at the temperature of 35 °C, it decreased from 3.70 mg to 2.92 mg.

Decreasing vitamin C content was caused by respiration and oxidation process of vitamin C to be dehydro-L-ascorbic acid and continue to change into diketo-L-gulonic acid without active vitamin C. At room temperature, vitamin C decreases faster since the temperature of environment condition cannot be controlled, where the existence of heat and oxygen that damages vitamin C easily (Sudarmadji, 2007).

Nutrient losses during heating process depends on duration or temperature treatment and the speed of heat transfer to the product so that commercial development will be focused on the improvement of the speed of heat transfer to the product. Other than the vitamin A that was expected to contain in salt fortification with dragon fruit peel, vitamin C content is also expected to be the antioxidant so that those vitamins can be retained during storage process. The use of LDPE and HDPE plastic packaging did not cause any changes on vitamin C content, yet surrounding environment gives more influence on it.

CONCLUSION

Different packaging type and storage temperature did not have real impact on NaCl and vitamin A content of salt fortification with dragon fruit peel. NaCl content in fortification of salt with dragon fruit peel in LDPE packaging at the room temperature for the first week was 92.95%, the second week was 91.2% and the fourth week was 88.78%. Vitamin A content during storage period at room temperature and at the temperature of 35 °C in LDPE and HDPE plastic packaging was ranging from 4.09 mg to 4.10 mg. Water content of fortification of salt with dragon fruit peel is affected by storage temperature. Water content of salt fortification with dragon fruit peel at room temperature using LDPE plastic for first week was 0.79% and then decreased to 0.7%. Meanwhile, at the temperature storage of 35 °C in the first week was 0.22% and in the fourth week was 1.93%. Packaging type give a real impact on vitamin C content in LDPE and HDPE plastic packaging when stored at the room temperature and the temperature of 35 °C. Vitamin C content in salt fortification with dragon fruit peel was 4.05 mg and during storage period at room temperature using LDPE and HDPE plastic packaging, it decreased to 2.30 mg. Meanwhile, at the temperature of 35 °C, it decreased from 3.70 mg to 2.92 mg. Salt fortification with dragon fruit peel is able to bind vitamin C, so this fortification can be used as an alternative of vitamin C source.

Sensory test and storage period prediction in salt fortification with dragon fruit peel are highly needed. The addition of impurity binder ingredients and recrystallization process were necessary to produce salt with higher NaCl content.

ACKNOWLEDGMENT

We would like to express our gratitude to LPPM - UTM for the funding assistance through Research for Beginner Lecturer grant in 2018 Budget Year.

References

Almatsier, S. (2013). *Prinsip Dasar Ilmu Gizi*. Jakarta: Gramedia Pustaka Utama.

Amin, F., Zulys, A., & Bakri, R. (2017). Fortifikasi dan ketersediaan zat besi pada bahan pangan berbasis kedelai menggunakan besi edta, glisinat, fumarat, dan suksinat. *Jurnal ITEKIMA (Jurnal Ilmiah Ilmu Dan Teknologi Kimia)*, *1*(1), 95–106.

AOAC. (1984). *Official Method of Analysis of the Association of Official Analytical of Chemist* (18th ed.). Washington DC: Association of Official Analytical Chemists.

Badan Standardisasi Nasional. SNI 3556:2010. Garam Konsumsi - Yodium (2010). Indonesia.

Broto, W., & Kusumayanti, H. (2007). Perbaikan proses iodisasi garam dengan sistem injeksi di Kabupaten Pati. *Gema Teknologi*, *15*(2), 78–81.

Davis, J. S. (2013). Structure, function and management of the biological system for seasonal solar saltworks. *Global NEST Journal*, *2*(3), 217–226. https://doi.org/10.30955/gnj.000175

Day, R. A., & Underwood, A. L. (1996). *Analisis Kimia Kuantitatif* (5th ed.). Jakarta: Erlangga.

Dwidjoseputro, D. (2005). *Dasar-dasar Mikrobiologi*. Jakarta: Djambatan.

Gemati, A., Gunawan, & Khabibi. (2013). Pemurnian garam NaCl melalui metode rekristalisasi garam krosok dengan penambahan Na2CO3, NaOH dan polialuminium klorida untuk penghilangan pengotor Ca2+dan Mg2+. *Jurnal Kimia Sains Dan Aplikasi*, *16*(2), 50–54. https://doi.org/10.14710/jksa.16.2.50-54

Handayani, P. A., & Rahmawati, A. (2012). Pemanfaatan kulit buah naga (dragon fruit) sebagai pewarna alami makanan pengganti pewarna sintetis. *Jurnal Bahan Alam Terbarukan*, *1*(2), 19–24.

Hilal, M. F., Handayani, S., & Atun, S. (2010). *Identifikasi Senyawa Metabolit Sekunder dari Kulit Buah Naga (Hylocereus undatus) dalam Ekstrak Kloroform*. Skripsi. Jurusan Pendidikan Kimia. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Negeri Yogyakarta. Sleman.

Howson, C. P., Kennedy, E. T., & Horwitz, A. (1998). *Prevention of Micronutrient Deficiencies: Tools for Policymakers and Public Health Workers*. Washington, D.C.: National Academies Press. https://doi.org/10.17226/5962

Hui, Y. H. (2006). *Handbook of Food Science Technology and Engineering*. New York: Taylor & Francis Group.

Jumaeri, Sulistyaningsih, T., & Sunarto, W. (2017). Inovasi pemurnian garam (natrium klorida) menggunakan zeolit alam sebagai pengikat impuritas dalam proses kristalisasi. *Sainteknol : Jurnal Sains Dan Teknologi*, *15*(2), 147–156.

Martianto, D., Marliyati, S. A., & Arafah, A. A. (2009). Retensi vitamin A pada minyak goreng curah yang difortifikasi vitamin A dan produk gorengannya. *Jurnal Teknologi Dan Industri Pangan*, *20*(2), 83–89.

Masero, J. A. (2003). Assessing alternative anthropogenic habitats for conserving waterbirds: salinas as buffer areas against the impact of natural habitat loss for shorebirds. *Biodiversity and Conservation*, *12*(6), 1157–1173. https://doi.org/10.1023/A:1023021320448

Maulana, K. D., Jamil, M. M., Putra, P. E. M., Rohmawati, B., & Rahmawati. (2019). Peningkatan kualitas garam bledug kuwu melalui proses rekristalisasi dengan pengikat pengotor CaO, Ba(OH)2, dan (NH4)2CO3. *Journal of Creativity Students*, *2*(1), 42–46.

Noor, M. I., Yufita, E., & Zulfalina. (2016). Identifikasi kandungan ekstrak kulit buah naga merah menggunakan fourier transform infrared (FTIR) dan fitokimia. *Journal of Aceh Physics Society*, *5*(1), 14–16.

Nurhidayati, L. (2007). Spektofotometri derivatif dan aplikasinya dalam bidang farmasi. *Jurnal Ilmu Kefarmasian Indonesia*, *5*(2), 93–99.

Nurliyana, R., Zahir, I. S., Suleiman, K. M., ‘Aisyah, M. R., & Rahim, K. K. (2010). Antioxidant study of pulps and peels of dragon fruits: a comparative study. *International Food Research Journal*, *17*(2), 367–375.

Permatasari, S. M., Helmiyati, S., & Iskandar, S. (2017). Stabilitas kadar iodium dalam garam fortifikasi kalium iodida (KI) menggunakan NaFeEDTA. *Darussalam Nutrition Journal*, *1*(1), 8–15. https://doi.org/10.21111/dnj.v1i1.1022

Rahayu, R., Astawan, M., & Syarief, R. (2003). *Penambahan Rumput Laut Eucheuma cottonii untuk Memperkaya Kandungan Iodium dan Serat Pangan Makanan Jajanan*. Skripsi. Jurusan Teknologi Pangan dan Gizi. Fakultas Teknologi Pertanian. Institut Pertanian Bogor. Bogor.

Shalaby, A., & Shanab, S. M. M. (2013). Antioxidant compounds, assays of determination and mode of action. *African Journal of Pharmacy and*

Pharmacology, *7*(10), 528–539. https://doi.org/10.5897/AJPP2013.3474

Siagian, A. (2003). *Pendekatan Fortifikasi Pangan untuk Mengatasi Masalah Kekurangan Zat Gizimikro*. Universitas Sumatera Utara: Medan.

Siracusa, V. (2012). Food packaging permeability behaviour: A report. *International Journal of Polymer Science*, *2012*, 1–11. https://doi.org/10.1155/2012/302029

Siregar, N. K., Rosidah, & Aris, S. (2011). *Karakterisasi Simplisia dan Skrining Fitokimia serta Uji Aktivitas Antioksidan Ekstrak Etanol Buah Naga (Hylocereus undatus (Haw.) Britton & Rose)*. Skripsi. Fakultas Farmasi. Universitas Sumatera Utara. Medan.

Stintzing, F. C., Schieber, A., & Carle, R. (2002). Betacyanins in fruits from red-purple pitaya, Hylocereus polyrhizus (Weber) Britton & Rose. *Food Chemistry*, *77*(1), 101–106. https://doi.org/10.1016/S0308-8146(01)00374-0

Sulistyaningsih, T., Sugiyo, W., & Sedyawati, S. M. R. (2010). Pemurnian garam dapur melalui metode kristalisasi air tua dengan bahan pengikat pengotor Na2C2O4 – NaHCO3 dan Na2C2O4 – Na2CO3. *Sainteknol : Jurnal Sains Dan Teknologi*, *8*(1), 26–33.

Widayat. (2009). Production of industry salt with sedimentation – microfiltration process: optimization of temperature and concentration by using surface response methodology. *TEKNIK*, *30*(1), 11–18.

Wijaya, C. H., Yuliasih, I., & Sugiarto. (2007). *Pendugaan Umur Simpan Produk Kopi Instan Formula Merek-Z dengan Metode Arrhenius*. Skripsi. Departemen Teknologi Pertanian. Fakultas Teknologi Pertanian. Institut Pertanian Bogor. Bogor.

Winarno, F. G. (2004). *Kimia Pangan dan Gizi*. Jakarta: Gramedia Pustaka Utama.

Wu, L., Hsu, H.-W., Chen, Y.-C., Chiu, C.-C., Lin, Y.-I., & Ho, J. A. (2006). Antioxidant and antiproliferative activities of red pitaya. *Food Chemistry*, *95*(2), 319–327. https://doi.org/10.1016/j.foodchem.2005.01.002

Zainuri, M., Anam, K., & Susanti, A. P. (2016). Hubungan kandungan natrium chlorida (NaCl) dan magnesium (Mg) dari garam rakyat di Pulau Madura. In *Prosiding Seminar Nasional Kelautan* (pp. 167–172). Bangkalan: Universitas Trunojoyo Madura.