Effect of green spinach (*Amaranthus tricolor* L.) and tomato (*Solanum lycopersicum*) addition in physical, chemical, and sensory properties of marshmallow as an alternative prevention of iron deficiency anemia

B Yudhistira, D R Affandi and P N Nusantari*
Food Science and Technology, Universitas Sebelas Maret, Surakarta
57101, Indonesia

*Email : nimasnusantari17@gmail.com

**Abstract.** Iron deficiency anemia is the most common nutritional disorder in the world. Consuming vegetable which contain iron, including spinach, is an alternative to fulfill iron requirement. Fe will be more easily absorbed in the presence of vitamin C. Tomato is one of vitamin C source that can be used. Spinach can be applied into confectionary products in the form of marshmallow. This research aimed to find out the physical, chemical and sensory properties of green spinach Marshmallow in addition of Tomato, the best formula, and define the category of nutrition contents based on Acuan Label Gizi (ALG). This study used a completely randomized design (CRD) with one factor that was different proportion of spinach:tomato (75%: 25%; 50 %: 50%; 25%: 75%). The data were analyzed using One Way Anova with 5% significance level. The result of this study showed that the difference of spinach and tomato proportion affect tensile strength, moisture, ash content, Fe content, crude fiber, vitamin C, color and marshmallow’s flavor. Best marshmallow formulation of 25% spinach in addition of 75% tomato had Fe content of 1.159 mg/ 100g and vitamin C of 44 mg/100g.

**Keywords:** marshmallow, green spinach, tomato

1. **Introduction**

Anemia is the most common and widespread nutritional disorder in the world. The most common anemia is iron deficiency anemia which caused by the deficiency of iron and can be suffered by anyone including infants, children, even adults, both men and women [1]. Data in 2013 shown that the proportion of anemia suffered by people aged 15-24 years old in amount of 18.4% from the whole group of 1-75 years old [2]. One effort that can be done to overcome iron deficiency anemia is iron fortification. Iron can be obtained from vegetables, including spinach (*Amaranthus tricolor* L.), which has an iron content of 3.9 mg/100g [3]. Spinach is considered as a good source of vitamins (ascorbic acid, riboflavin, niacin, and folic acid), minerals (iron and calcium) and dietary fibers [4].

The nutritional component in spinach is a series of complementary compositions, e.g. Fe, will be more easily absorbed in the presence of vitamin C. Also described by Hallberg et al [5] that vitamin C is a strong promoter of iron absorption from food and can counter the inhibitory effects of phytate and
tannin. However, vitamin C content easily decreases during processing, so apart from spinach, iron absorption can be helped by vitamin C from other ingredients such as tomato. The benefits contained in spinach as a source of iron will not support the prevention of anemia if the amount of consumption is low. So it is needed to have vegetable products in other forms that potential to be accepted by the community. Spinach can be applied to confectionery food product, which is one form of food products. One of confectionery product that can be consumed by wide range of age is marshmallow. The innovation of marshmallow-shaped vegetable processing will ease the increase in vegetable consumption. The formation of marshmallow texture is influenced by gelatinizing agent, one of them is pectin [6]. Spinach has 11.58% pectin content and tomato (Solanum lycopersicum), which has 4.63% pectin content. This spinach and tomato added can play a role in the formation of marshmallow texture.

Making green spinach marshmallow with the addition of tomato is expected to be one of the processed foods that can meet the needs of iron and can be an alternative food fulfillment of iron in the wide range of community. Furthermore, the addition of tomato in the manufacture of marshmallow is expected to help the maximum absorption of iron levels in the body. This research conducted to know the physical, chemical, and organoleptic characteristics of marshmallow, the best formula, and the nutritional group of marshmallow based on Acuan Label Gizi (ALG).

2. Materials and methods

2.1. Materials

Materials used in the manufacture of marshmallows are green spinach (Amaranthus tricolor L.), red tomato (Solanum lycopersicum) (Karanganyar, Indonesia), linear gelatine (Edible Bovine Gelatine), liquid sorbitol, citrus essence, icing sugar, cornstarch, as well as ingredients for other analysis of jewawut (Setaria Italica), xylene, aquades, concentrated HCl solution, blue bromophenol indicator, sodium acetate, sterilizing solution, ascorbic acid, acetic acid, thio urea, 2,4-dinitrophenyl hydrazine, sulphuric acid, bromine water, potassium iodide, potassium iodate (KIO3), sodium thiosulphate, starch Solution, NaOH, K2SO4 solution, and 95% alcohol.

2.2. Spinach and Tomato Extract

Spinach and tomato steamed for 5 minutes for spinach and 7 minutes for tomato at 100°C and drained. After slicing, smoothing or spinning of spinach and tomato is done using a juicer.

2.3. Marshmallow

The making of marshmallow divided into two stages, the first was mixing the spinach and tomato extract that has been cooled according to the formula (75%: 25%; 50%: 50%; 25%: 75%) with gelatin 43.2 grams until it dissolved and let it for 10 minutes. In stage two, spinach and tomato according to the formula were heated by adding 200 ml sorbitol for 5 minutes to be boiled and foamed. Next, mixed the results of stages 1 and 2 in the basin by mixer until formed foam. If foam started to form, added essence citrus and mixing for 30 minutes. Marshmallow poured on a baking sheet covered with bread paper and icing sugar mixed with cornstarch. After flattening, the top surface of marshmallow sprinkled with icing sugar that mixed with cornstarch. The next stage was curing for 10 to 12 hours [7] with modification.

2.4. Physical, Chemical, and Sensory Analysis

Physical analyzes included tensile strength using the Zwick /Z0.5 Universal Testing Machine (BLGRS500N), density test [8]. While chemical analyzes include of water content of thermovolumetric method [9], ash oven method [10], Atomic Absorption Spectrophotometer [11], crude fiber acidic method [11], Vitamin C concentration of spectrophotometric methods [12], and organoleptic tests with hedonic Scoring and Ranking tests [13].
2.5. Data Analysis
This study used a completely randomized design (CRD) with one factor that was different proportion of spinach : tomato (75%: 25%; 50%: 50%; 25%: 75%). The data were analyzed using One Way Anova with 5% significance level.

3. Results and discussion
3.1 Physical Characteristics of Marshmallow Green Spinach (Amaranthus tricolor L) in addition of Tomato (Solanum lycopersicum)

| Parameter                        | Formulation | Tensile Strength (Fmax) (N) | Density (g/ml) |
|----------------------------------|-------------|-----------------------------|----------------|
|                                  | M1          | 0.558 ± 0.027               | 0.476 ± 0.008  |
|                                  | M2          | 0.428a ± 0.059              | 0.485a ± 0.008 |
|                                  | M3          | 0.376a ± 0.007              | 0.538a ± 0.050 |

\( a = \text{subset a, } b = \text{subset b, } a \text{ and } b \text{ in one column show a significant difference at } \alpha = 0.05, \text{ M1 : Spinach 75%:Tomato 25%, M2 : Spinach 50%:Tomato 50%, M3 : Spinach 25%:Tomato 75%} \)

Physical characteristic of marshmallow determined by the value of tensile strength and density. The value of tensile strength marshmallow green spinach with the addition of tomato increased with the greater concentration of spinach, but density test shown the different result. The difference of spinach and tomato concentration on marshmallow has no effect on density value. It can be seen in Table 1 that the highest tensile strength value in marshmallow M1 (0.558 N). The high value of tensile strength shown that the quality of marshmallow produced is better.

The formation of marshmallow texture is influenced by the presence of pectin, pectin in spinach and tomato in the form of polysaccharide can be used as a thickener in food, besides gelatin which is a protein and used as an emulsifier. Gelatin is responsible for gel formation, with the help of pectin providing a protective coating so that marshmallows can be stable during storage [14]. Therefore, marshmallow requires conjugation of polysaccharides and protein to obtain froth [15]. The ionic interaction effect between proteins and pectins results in increase of foam stability and no effect indicating that the foam layer is thickened in any sample. Proteins contribute to the foaming capacity and foam formation, while the soluble pectin complex decreases the drainage which ultimately gives foam stability [16]. Foam is a thermodynamically unstable system. As for the foam, it can be stable because of the factors that one of them is drainage. The presence of protein combined with carbohydrates will reduce the drainage to become a stable system [17].

3.2 Chemical Characteristics of Marshmallow Green Spinach (Amaranthus tricolor L) in addition of Tomato (Solanum lycopersicum)

There are 5 parameters observed in chemical characteristics. Table 2 shows that the concentration of spinach and tomatoes used has an effect for all parameters, but the kind of effect is different for each parameter. The highest water content value was found on marshmallow M1 (17.562%). This is due to high water content in foodstuffs influenced by several things including chemical content, such as protein clusters, polysaccharides, or fiber. The fiber (polysaccharide), in food affects the process of water absorption because in the fiber there are enough polar free hydroxyl groups [18], so that the water can form hydrogen bonds with hydroxyl groups (-OH) [19]. So the less fiber content the higher the water content. According to the Badan Standarisbury Nasional [20] for soft jelly candy (Indonesia...
National Standard 3547-2-2008), the maximum water content is 20%. It means that the water content of marshmallow is accordance with the Indonesian National Standard.

### Table 2. Chemical Characteristics of Marshmallow Green Spinach (*Amaranthus tricolor* L) in Addition of Tomato (*Solanum lycopersicum*).

| Parameter          | Formulation | Water Content (%) | Ash Content (%db)* | Fe Content (ppm)* | Crude Fiber (%db)* | Vitamin C (%wb)* |
|--------------------|-------------|-------------------|--------------------|-------------------|-------------------|-----------------|
|                    | M1          | 17.562±0.276      | 0.441±0.013        | 45.744±4.767      | 0.079±0.0390.021±0.001 |                  |
|                    | M2          | 15.572±0.001      | 0.351±0.013        | 31.838±0.567      | 0.104±0.007       | 0.024±0.001     |
|                    | M3          | 11.709±0.016      | 0.223±0.008        | 11.594±1.053      | 0.160±0.008       | 0.044±0.002     |

* a = subset a, b = subset b, a and b in one column show a significant difference at α = 0.05, M1 : Spinach 75% : Tomato 25%, M2 : Spinach 50%:Tomato 50%, M3 : Spinach 25%:Tomato 75%.

The ash content ranged from 0.2-0.4 (% db) or 0.16-0.37 (% wb). Marshmallow as one of the jelly soft candy products has values that meet the standards set by SNI, according to Badan Standarisasi Nasional [20] for soft jelly candy (Indonesia National Standard 3547-2-2008), ash content has a maximum limit of 3%. Spinach has a content of ash of 0.6-3.1% [21] and tomato has an ash content of 0.39-0.6% [22] so the higher concentration of spinach added the higher the ash content in marshmallows. The highest ash content was found on marshmallow M1 (0.441%). The lowest ash content was found on marshmallow M3 (0.223%). Marshmallow M3 is the best because the less ash the better is the quality of marshmallow produced [23].

Spinach has a high Fe content of 3.9 mg/100 g [3] compared to tomato that containing only 0.5 mg /100 g [24] to 0.81 mg/100 g (MOH , 1990 in Fitri [25]. So the addition of more green spinach will increase iron levels. Marshmallow with the highest iron content found in marshmallow M1 that is equal to 45.7437 ppm (4.574 mg/ 100 gram). The iron content in marshmallow has the same value as the ingredients used. This is because according to [26], iron content will survive at high temperatures.

According to Kusharto [27], tomato has a crude fiber content of 1 gram per 100 grams higher than spinach with 0.8 grams per 100 grams. Rough fibers comprising cellulose, hemicellulose, and lignin are insoluble fibers. Since this fiber is not water soluble, its presence is still present in the final product [28]. Marshmallow M3 has the highest crude fiber content is 0.160%.

Vitamin C levels in marshmallows were not significantly different for M1 marshmallow and marshmallow M2 but differed significantly with M3 marshmallows. The highest vitamin C values were found in marshmallow M3 (0.044%). The higher the concentration of tomato used, the higher the vitamin C. Even though tomato has vitamin C content of 40 mg/100 grams [29] lower than spinach that has vitamin C content of 80 mg/100 grams to 629 mg/100 grams in fresh condition and 299.7 mg/100 gram with blanching for 5 minutes [30], the pretreatment is different between tomato and spinach. During the processing, tomato is treated to avoid the decreasing of vitamin C level by cooling in the refrigerator, which according to Syafutri et al [31], the cold temperature used (10°C) were causing the metabolic activity in the fruit runs slower so that the decreasing of organic acids (ascorbic acid) contained also slower. While spinach more treated to the heat, in mixing with sorbitol it is heated by boiling. Glucose, sucrose, and sorbitol can protect ascorbic acid from degradation at low temperatures (<40°C), but at high temperatures (>70°C) will cause ascorbic acid damage [32].

According to Hallberg et al. [5,40] that vitamin C is a strong promoter of iron absorption from food and can counteract the inhibitory effects of phytate and tannin. Vitamin C can increase iron absorption when taken at the same time because vitamin C will convert iron from ferrite form to ferrous form. Iron in the form of fero is more easily absorbed. Spinach and tomato used in marshmallow making materials were given preliminary treatment to increase the availability of iron. Spinach and tomato are given a blanching treatment first. Heat treatment increases iron availability by 32.5% [33] and according to Kurniawan (2007) in [26], blanching and increasing cook time increase iron availability.
Acuan Label Gizi (ALG) is a reference of information inclusion about nutritional content on food product label. According to the Regulation of the Head of Food and Drug Supervisory Authority of the Republic of Indonesia Number 13 of 2016 [34], on Claim Supervision on Labels and Advertisements of Processed Foods, a vitamin or mineral is said to have nutrients as a source if it contains 15% ALG per 100 grams (in solid form) or 7.5% ALG per 100 ml (in liquid form) and is said to be high/rich if the product contains twice of vitamins or minerals content for "source". On the Regulation of the Head of Food and Drug Supervisor of Republic of Indonesia Number 9 Year 2016 [35], Label of Nutrition shows that ALG value for iron is 22 mg (15% ALG: 3.3 mg for "source" and 6, 6 mg for "high/rich"), and for vitamin C of 90 mg (15% ALG: 13.5 mg for source and 27 mg for "high / rich").

In green spinach marshmallows with the addition of tomatoes, the best formula is found in the M3. Marshmallow M3 has iron content of 1.159 mg / 100 gram and vitamin C at 0.044% or 44 mg / 100 gram. M3 marshmallow iron levels do not include "source" or "high/rich" because they are lower than 15% ALG per 100 grams. While the vitamin C content of marshmallow M3 including "high/rich" because higher than the provision of the number of "source" ALG. Thus, green spinach marshmallow with the addition of tomato allowed as an alternative food to prevent iron deficiency anemia. Although the best formulation of marshmallow has less iron content than source which is only 1.159 mg / 100 gram, the amount is meet the recommended daily Nutrient Adequacy Ratio (AKG) of iron for age 0-9 About 3-10 mg. Men over 9 years of age of 13-17 mg, and women over 9 years of age 14-26 mg (Supariasa et al 2000 in [36]) should consume according to the number of marshmallows required to meet the amount of the iron needed.

3.3 Sensory Characteristics of Marshmallow Green Spinach (Amaranthus tricolor L) in addition of Tomato (Solanum lycopersicum)

| Formulation | Color | Aroma | Flavor | Texture | Overall |
|-------------|-------|-------|--------|---------|---------|
| M1          | 3.23<sup>a</sup> | 3.23<sup>a</sup> | 2.63<sup>a</sup> | 3.55<sup>a</sup> | -0.30<sup>a</sup> |
| M2          | 3.03<sup>a</sup> | 3.60<sup>a</sup> | 3.00<sup>a</sup> | 3.65<sup>a</sup> | -0.15<sup>a</sup> |
| M3          | 3.85<sup>b</sup> | 3.33<sup>a</sup> | 3.45<sup>b</sup> | 3.73<sup>a</sup> | 0.45<sup>b</sup> |

<sup>a</sup> = subset a, <sup>b</sup> = subset b, a and b in one column show a significant difference at α = 0.05, M1: Spinach 75% : Tomato 25%, M2: Spinach 50%:Tomato 50%, M3: Spinach 25%:Tomato 75%.

* Ranking Test: The largest number shows the highest level of favorite and followed by the next small number. M1: Spinach 75%:Tomato 25%, M2: Spinach 50%:Tomato 50%, M3: Spinach 25%:Tomato 75%.

The determination of the value done by panelist giving score from 1 to 5, the higher value obtained indicate it is more preferred by panelist. Table 3 shows the panelist's preference for the color of marshmallow not significantly different for M1 and M2 but significantly different from M3. Marshmallow M1 and M2 colors is brownish yellow with green spots obtained from green spinach, while on M3 has whitish orange color. Thus panelists prefer the M3 marshmallow with the colors tend to be bright (red). Differences in green spinach concentration with the addition of tomatoes have an effect on the color characteristics of marshmallows. The panelist's favorite level on this color parameter is allegedly influenced by the color of the marshmallow material, which is chlorophyll from spinach [21] to contribute green color, while the tomato is known to have a red color contributed by carotenoid and lycopene. Lycopene is a natural pigment found in plants [37].
The level of panelist acceptance of the scent is not significantly different between formulas. The absence of this difference is due to the addition of citrus essence with the same concentration for all treatments which aimed to provide a preferred scent to cover the typical odor of gelatin due to cooking [23]. Indonesia National Standard (2008) mentioned that the quality requirement of soft jelly soft candy oil is normal.

The panelist acceptance level for taste is not significantly different for marshmallow M1 and M2 but different from M3. The highest panelist favor value for taste parameter is for marshmallow M1 because tomato has a varied flavor from sour to sweet [38].

The texture of the marshmallow did not differ between the formulas. The process of making is done by the same method to produce a uniform texture. Gelatin is used to improve marshmallow aeration and texture. Gelatin absorbs water to form a thick solution. Thus gelatin used in equal amounts causing the resulting marshmallow texture to be the same.

3.4 Determination of Green Spinach Marshmallow Formulation (Amaranthus tricolor L) with the Best Addition of Tomato (Solanum lycopersicum)

The best formula determination of green spinach marshmallow with the addition of tomato is done by compensatory model or weighted test [39]. Thus, after passing the organoleptic test in determining the panelist's preference for the product, we then conduct a weighted test to select the preferred formula of the organoleptic parameters as well as the physical and chemical characteristics. The best formula is the treatment with the highest value score of the degree of product interest expected by the consumer. The best formula with the highest yield value is M3. Therefore, Formula M3 with 25% green spinach concentration and 75% tomato is the right combination in marshmallow formula of green spinach and tomato.

4. Conclusion

The physical characteristics of green spinach marshmallow (Amaranthus tricolor L) with the addition of tomato (Solanum lycopersicum) are tensile strength of 0.376-0.558 N and density of 0.476-0.538 g/ml while the chemical characteristics are moisture content of 11.709-17.562% (wb), ash content of 0.223-0.441% (db), Fe content of 11.594-45.744 ppm (db), crude fiber content of 0.079-0.160% (db), and vitamin C levels of 0.021-0.044% (wb). The higher the tomato concentration affected to the sensory characteristic, the color and taste of marshmallows tend to be preferred. Overall, marshmallow green spinach 25% with the addition of 75% tomato is the most preferred formula. Thus proportion of spinach and tomato also the best formula which classified as high / rich in vitamin C that is 44 mg / 100 gram according to the Nutritional Label Reference (ALG).

5. References

[1] World Health Organization 2008 Worldwide Prevalence of Anaemia 1993-2005 WHO Global Database on Anaemia. Ed. Benoist et al. (acceded at March 16th 2016)
[2] Kadafi M 2015 Influence of Iron Tablet and Vitamin C to Hemoglobin Levels of Undergraduate Students of Nursing University of Muhammadiyah Surakarta Published Research Universitas Muhammadiyah Surakarta

[3] Faridah A and Novita S 2014 The addition of spinach (Amaranthus tricolor L) in the manufacture of cookies as fortification Fe. Proceedings FKPT-TPI Universitas Riau

[4] Ankita and Prasad K 2013 Studies on Spinach Powder as Affected by Dehydration Temperature

[5] Hallberg L, Brune M, Rossander-Hulthén L 1987 Is there a physiological role of vitamin c in iron absorption Annals of the New York Academy of Sciences 498 p 324-32

[6] Koswara S 2009 Confectionary Technology Ebook Pangan.com

[7] Ginting N A, Herla R and Rona N 2014 The effect of comparison of red guava with lemon and gelatin concentration to the quality of red guava marshmallow J. Rekayasa Pangan dan Pertanian 2 p 16-20

[8] Ramli E 2010 Effect of gelatin concentration and the ratio of sucrose - glucose syrup to the physicochemical and organoleptic properties of marshmallow rosella Undergraduate Thesis Universitas Katolik Widya Mandala Surabaya

[9] Sudarmaji S, Suhardi and Haryono B 1989 Analysis of Food and Agricultural Materials Yogyakarta: Liberty Yogyakarta

[10] AOAC (Associaton of Official Analytical Chemistry) 2005 Official Methods of Analysis. 18th edition. Marylan: Association of Official Analytical Chemist inc. Gaithersburg

[11] AOAC (Associaton of Official Analytical Chemistry) 2002 Official Methods of Analysis. 17th edition. Marylan: Association of Official Analytical Chemist inc. Gaithersburg

[12] Majidi M I H A and Y-AlQubury H 2016 Determination of vitamin c (ascorbic acid) content in various fruit and vegetable by UV-spectrophotometry and titration methods J Chem. and Pharmaceutical Sci (4) p 2972

[13] Kemp S E, Tracey H and Joanne H 2009 Sensory Evaluation a Practical Handbook Macmillan Publishing Solutions. Singapore

[14] Dickinson E 2003 Hydrocolloids at interfaces and influence on the properties of dispersed system. food hydrocolloids 17 p 30-1

[15] Suryani R and Fithri C N 2015 Modified cassava starch (Manihot esculenta ZLWKĮ -amylase enzyme as a foaming agent and its application in the process of making marshmallow J. Pangan dan Agroindustri 3 p 731

[16] Schmidt I, B. Novales, F Boue, and M.A.V Axelos 2010 Foaming properties of protein/pectin electrostatic complexes and foam structure at nanoscale J. Colloid and Interface Sci. 345 p 316

[17] Damodaran S 2005 Protein stabilization of emulsions and foams J. Food Sci. 70 R54–R66

[18] Winarti S 2010 Functional Food Yogyakarta: Graha Ilmu

[19] Wahyuni S 2015 Production and evaluation of physical, chemical and sensory properties of fruit leathers of apple manalagi (Mallus sylvestris mill) with variation of xanthan gum concentration Undergraduate Thesis Universitas Sebelas Maret. Surakarta

[20] BSN (Badan Standardisasi Nasional) 2008 Indonesia National Standard 3547.2:2008. http://sisni.bsn.go.id (acceeded at November 9th 2016)

[21] Fatimah S 2009 Study of chlorophyll and iron (fe) levels on some types of spinach on the number of white mouse erythrocytes (Rattus Norvegicus) Anemia Undergraduate Thesis Universitas Islam Negeri Maulina Malik Ibrahim. Malang

[22] Suarez M, Hernandez E M. Rodriguez, and C D Romero 2008 chemical composition of tomato (Lycopersicon esculentum) from Tenerife, the Canary Islands Food Chemistry 106 p 1049

[23] Sartika D 2009 Development of marshmallow products from red snapper fish gelatin (Lutjanus Sp.) Undergraduate Thesis Institut Pertanian Bogor.

[24] Arifulloh 2013 Lycopene Extraction from Tomato Fruit (Lycopersicum esculentum Mill.) With Various Solvent Compositions Undergraduate Thesis Universitas Jember.
[25] Fitri A 2016 Pectin from the skin of cocoa fruit (theobroma cacao l.) As an edible coating of tomatoes Research Universitas Halu Oleo Kendari

[26] Dewi A A 2014 Evaluation of sensory and chemical properties of mp-ation based on pumpkin flour (Cucurbita moschata), spinach (Amaranthus sp) and red beans (Phaseolus vulgaris L.) by drying method of spray drying Undergraduate Thesis Universitas Sebesas Maret. Surakarta

[27] Kusharto C M 2006 Dietary fiber and its role for health J. Gizi dan Pangan 1 p 48-9

[28] Chinachotti P, M P Steinberg, and R. Villota 1990 A model for quantitating energy and degree of starch gelatinization based on water, sugar and salt contents J. Food Sci. 55

[29] Firmanto, B.H 2011 Success of Organic Tomatoes Bandung: Angkasa

[30] Yadav S K, and Salil S 1995 effect of home processing on ascorbic acid and β-carotene content of spinach (Spinacia Oleracia) and amaranth (Amaranthus tricolor) leaves. Plant Foods for Human Nutrition 47 p 128

[31] Syafutri M I, Filli P and Daniel S 2006 Physical and chemical properties of mango fruit (Mangifera indica L.) during storage with various packaging methods J. Teknologi dan Industri Pangan 17 p 2-9

[32] Octaviani L F and Rahayuni A 2014 Effect of various concentrations of sugar on antioxidant activity and the level of acceptance of buni juice (Antidesma bunius) J. Nutrition College 3 p 958-65

[33] Shi J and Marc L M 2000 Lycopene in tomatoes: chemical and physical properties affected by food processing Critical Reviews in Food Science and Nutrition 40 p 2

[34] Regulation of the Head of the National Agency for Drug and Food Control of the Republic of Indonesia 2016 Claim Monitoring on Food Label and Advertisement Number 13

[35] Regulation of the Head of the Food and Drug Supervisory Agency of the Republic of Indonesia 2016 Nutrition Status Reference Number 9

[36] Manampiring, Aaltje E. 2008. Prevalence of Anemia and Iron Adequacy Level in Primary School Children in Minusa Village, Wori Sub-district, North Minahasa District Scientific work. National Education Ministry RI. Medical Faculty. Universitas Sam Ratulangi. Manado.

[37] Shi J and Marc L M 2000 Lycopene in tomatoes: chemical and physical properties affected by food processing Critical Reviews in Food Science and Nutrition 40 p 2

[38] Maulida D and Zulkarnaen N 2010 Extraction of antioxidants (lycopene) from tomatoes using mixed solvents, n-hexane, acetone, and ethanol Undergraduate Thesis Universitas Diponegoro, Semarang.

[39] Sullivant W G, Elin M W and Patrick K C 2015 Engineering Economy Canada: Pearson Higher Education, Inc

[40] Ridwan E 2012 Study of iron interactions with other micronutrients in supplementation. Panel Gizi 35 p 49-54