Partial properties of young corn flour based on particle size and its effect on texture and sensory acceptability of biscuit

E Yusraini1* and N D A Lubis2

1Department of Food Science and Technology, Faculty of Agriculture, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.
2Department of Nutrition, Faculty of Medicine, Universitas Sumatera Utara, Medan, Sumatera Utara, Indonesia.

E-mail: *era.yusraini@usu.ac.id or era_yusraini@yahoo.com

Abstract. Utilization young corn can be applied into food products in the form of flour in order to increase the content of food fibre. Currently, there are no commercially-made biscuit-enriched food products from young corn flour. Based on this, it is necessary to conduct research on the particle size of young corn flour as a source of biscuit fibre. The purpose of this study was to determine the characteristics of young corn flour that passed the size of the sieve number, 40, 50, and 80 mesh and the effect of its addition to the texture value and the sensory acceptability of the biscuits. The results reported that young corn flour that passed from the sieve with a greater number resulted in the brighter colour of young corn flour towards yellowish white, lower of bulk density, and the increase of absorption of oil. All young corn flour treatments had no significant effect on water absorption and water solubility. Substituted biscuits provide a crisp texture and sensory reception which was quite similar to control biscuits (100% wheat flour) if using young corn flour that passed sieve number 40 with an additional percentage of 10%.

1. Introduction
Biscuits are one type of food that is practical for consumption. Besides, biscuits are complementary foods that are quite popular in Indonesia, including teenagers. Therefore, the addition of food fibre into biscuit products is also expected to help increase the amount of food fibre consumption, especially among teenagers who love to consume biscuits. Currently, biscuits enriched with fibre, such as wheat bran fibre, are already on the commercial market [1], [2]. Utilization of food fibre from young corn can be applied in the form of flour into food products that want to increase the content of food fibre because the content of high crude fibre (5.89% dry basis) and dietary fibre (29.2% dry basis) [3], compared to other vegetables [4]. From the literature study, young corn flour research to enrich food fibre, especially in biscuits, has been done [5], [6]. However, there are no references that give information pertaining to particle sizes of young corn flour as its function as dietary fibre sources, especially for biscuit products. Based on this condition, it is necessary to do research on the particle sizes and proportion of young corn flour as a source of fibre in biscuits.
2. Materials and methods

2.1. Production young corn flour
Firstly, baby corn or young corn was sorted and washed. Then, the corns were sliced (± 2-3 mm) and blanched with a water vapour temperature of 90°C for 10 minutes to prevent the browning reaction. The blanching products were dried using an oven blower at 50 °C for 24 hours, with a reversal in the first 6 hours of the drying process. Sliced dried young corn then mashed using a blender with a uniform amount of weight and time so that it became flour. The young corn flour was then treated to have uniform particle size i.e. 40, 50, and 80-mesh by a sieve screen with three replications (one factor used completely randomized design). Finally, each product with similar particle size was observed and analysed parameter data, namely yield (%), water content (%) [7], bulk density (g/ml) [8], water solubility (%) with modification [9], water absorption (g/g) and oil absorption (g/g) with modification [10].

2.2. Production biscuits with the addition of young corn flour
Biscuits were made based on the formulation (Table 1.) and the method of [11] with modifications using glass moulding to make its thickness uniformly. The treatment was conducted using a completely randomized design of two factors namely the particle size of young corn flour (M: 40; 50 and 80-mesh) and the proportion of wheat flour : young corn flour (P: 95:5; 90:10; 85:15; and 80:20) in 100 grams of total flour. Baked biscuits were stored for 2-7 days in aluminium packaging before analysis. Furthermore, texture analysis using manual grain texture analyser (Hardness Tester, Fujihara-Seisakusho LTD Japan), thickness used Vernier calliper, and texture score test by line-scale 0-100 (no crispness to very crispness) conducted by 30 panellists for each sample was performed. Finally, the best treatment biscuits were compared with the control biscuit which produced using 100% wheat flour on parameter texture, sensory acceptability of texture for crispness using the t-test.

| Ingredients               | Treatments (wheat flour : young corn flour) |
|---------------------------|-----------------------------------------------|
|                           | 95:5                          | 90:10               | 85:15                          | 80:20                          |
| Wheat flour (g)           | 95                            | 90                  | 85                              | 80                              |
| Young corn flour (g)      | 5                             | 10                  | 15                              | 20                              |
| Sugar (g)                 | 30                            | 30                  | 30                              | 30                              |
| Butter (g)                | 35                            | 35                  | 35                              | 35                              |
| Skim milk (g)             | 3                             | 3                   | 3                               | 3                               |
| Egg yolk (g)              | 15                            | 15                  | 15                              | 15                              |
| Baking powder (g)         | 4                             | 4                   | 4                               | 4                               |
| Salt (g)                  | 1                             | 1                   | 1                               | 1                               |
| Water (g)                 | 20                            | 20                  | 20                              | 20                              |

3. Results and discussion

3.1. Yield and partial properties of young corn flour passed at different sieve number
The analysis data obtained were the value of the yield of sliced dried young corn to skin peeled young corn and whole young corn (Table 2 and Figure 1). The whole young corn could only produce about 1.6% dried sliced young corn, due to the skin peeled young corn has reached around 22.2% and the corns had high moisture content which was around 90% as described by [3].

Firstly, it could be seen from data in Table 2 that the bulk density values of various sizes number sieves were significantly different. The highest bulk density was found in young corn flour which passes sieve number 40 (0.69 g/mL), and the lowest was young corn flour that passed sieve number 80 which was 0.60 g/mL. The difference of bulk density occurred due to flour which passed smaller sieve numbers
probably contained higher molecular weight in the same volume. Then, based on Figure 2, young corn flour which was passed higher sieve number was lighter on colour. The component that made the young corn became lighter was strongly assumed as starch which located in the deepest part of young corn. Normal corn kernels had starch content in its floury endosperm which was inside the kernels and was the largest proportion of the total endosperm [12]. Therefore, the smaller size of young corn flour would give more amount of starch than the fibre (crude or dietary). However, the content of crude fibre and starch were not analysed in this work.

Moreover, even though there was no significant difference (p>0.05) on the water absorption result (Table 2), the value showed that there was an increase of water absorption in the bigger particle size. The similar results were also proposed by [13] and [14]. Finally, on the contrary, oil absorption increased in smaller particle sizes or a higher number of sieve screen (Table 2). This phenomenon was in accordance too with [13] that reported the increase of fat absorption with a decrease in particle size of dietary fibre. The larger particle size may reduce the ability to absorb oil. Thus, the smaller particle size of young corn flour will increase the surface area which can increase oil absorption.

Table 2. The average yield of dried young corn

| Description                                      | Mean ± standard deviation (SD) |
|-------------------------------------------------|--------------------------------|
| Yield of skin peeled young corn to whole young corn (%) | 22.2 ± 0.74                    |
| Yield of sliced dried young corn to skin peeled young corn (%) | 7.4 ± 0.41                     |
| Yield of sliced dried young corn to whole young corn (%) | 1.6 ± 0.12                     |

Note: the number of repetitions is 9 times

Figure 1. Whole young corn (a), skin peeled young corn (b), sliced dried young corn (c)
3.2. Texture, thickness, and sensory texture properties of biscuit supplemented by young corn flour at a different particle size and percentage

Figure 3 presents the results of the texture of biscuits which had a significant difference (P<0.05) on the interaction of factor number of sieve screen and the proportion of flour (wheat flour and young corn flour). The biscuits would have a higher texture as the size of the sieve of the young corn flour and the percentage of flour substitutes for wheat flour increases. The smaller texture value of biscuits explains that the easier the biscuit is broken which means it had a lower hardness. However, the results of the texture test of biscuits substituted by young corn flour sieved by number 40 at all proportion of 5 to 20 of 100 grams flour were not significantly different (P>0.05) around 11.63 to 17.63 g/mm² whereas the biscuit control which used 100% wheat flour had texture around 15.85 g/mm². Therefore, adding the proportion of young corn flour up to 20 of 100 grams flour can still give a very crispy biscuit texture. This condition might be caused by young corn flour which passed through sieve number 40 had a low oil absorption, so it had more empty air cavities that could increase the ease of being broken which had a smaller texture value. Moreover, the size of young corn flour which was coarser gave space among biscuits component which can affect its lower texture hardness [15].
Note: M = number mesh

Figure 3. Texture biscuits in different sized particles (mesh) and percentage of wheat with young corn flour 95:5 (☺) \( y = 0.2533M + 4.6185 \); 90:10 (□) \( y= 0.3602M + 2.2003 \); 85:15 (*) \( y= 0.9665M - 25.128 \) and 80:20 (x) \( y = 0.9665 - 25.128 \)

Then, Figure 4 shows the results of thickness and texture sensory acceptability (score crispness) of biscuits. Both parameters only differ significantly on the factor of the proportion of flour (P<0.05), while it was not significantly different on the particle size of the young corn flour. The more proportion of young corn flour used, the lower the thickness and texture score of the biscuits produced. Therefore, this phenomenon shows that the role of gluten in wheat flour substituted in part with young corn flour is still very dominant influencing the thickness and score crispness of biscuits by sensory testing. Finally, the best percentage is obtained if the increase of young corn flour is done no more than 10%. This result was almost the same as [5]. However, that research was not analysed the particle size of the young corn flour.

Figure 4. Thickness and score crispness of biscuits on percentage of wheat flour with young corn flour in different size
Furthermore, the best treatment biscuits which were those added with young corn flour that passed sieve number 40 with the proportion of addition of 10 of 100 g flour compared to biscuits produced with 100% wheat flour which had a minimum 90% passes 80 mesh sieve (Table 4). Texture and score crispness of both types of biscuits were not different (P>0.05). However, the thickness of the best treatment was lower than the control. Therefore, the best treatment biscuit was concluded had an almost similar texture and score crispness properties with the control biscuits. The addition of young corn flour is expected to increase the fibre content of the best treatment biscuits. Based on the results of the previous study [3], substituting flour by 10% of young corn flour is estimated to add around 0.26% of the amount of crude fibre in the biscuits. This is expected to have a positive and functional effect on the health of the biscuits' consumers.

Table 4. Comparison the best treatment and control biscuits

| No. | Properties       | Best treatment       | Control         |
|-----|------------------|----------------------|-----------------|
| 1   | Texture (g/mm²)  | 16.45± ± 7.55        | 15.85a ± 3.29   |
| 2   | Thickness (mm)   | 5.56b ± 0.26         | 6.13± ± 0.13    |
| 3   | Score crispness  | 74.06a ± 2.90        | 75.88a ± 1.01   |

Note: Means in same bar which have different letter show difference significantly (p<0.05) by t-test

4. Conclusions
The biscuits which were added young corn flour which passed sieve number 40 in an additional percentage of 10% produced texture which almost similar to 100% wheat biscuits. Moreover, the young corn flour biscuits substituted would have a higher content of fibre which can give a positive effect on its consumer.

References
[1] Passos M E A, Moreira C F F, Pacheco M T B, Takase I, Lopes M L M and Valente-Mesquita V L 2013 Proximate and mineral composition of industrialized biscuits Food Sci. Technol. Campinas 33 (2) pp 323-31
[2] Norhayati M K, Mohd Fairulnizal M N, Zaiton A, Wan Syuriaht W Z, Rusidah S, Aswir A R, Ang J L, Mohd Naeem M N, Suraiami M, Mohd Azerulazree J and Vimala B 2015 Nutritional composition of selected commercial biscuits in Malaysia Sains Malaysiana 44 (4) pp 581–91
[3] Hooda S and Kawatra A 2013 Nutritional evaluation of baby corn (Zea mays) Nutrition & Food Science 43 (1) pp 68-73
[4] Gopalan C, Rama Sastri B V, Balasubramanian S C, Narasinga Rao B S, Doesthale Y G and Pant K C 1989 Nutritive value of Indian Foods (Hyderabad, National Institute of Nutrition ICMR)
[5] Jauharah A M Z, Wan Rosli W I and Daniel Robert S 2014 Physicochemical and sensorial evaluation of biscuit and muffin incorporated with young corn powder Sains Malaysiana 43 (1) pp 45–52
[6] Sandhu P P, Bains K, Singla G and Sangwan R S 2017 Utilization of corn fibre and pectin gel for the development of low Calorie and high fibre biscuits Current Journal of Applied Science and Technology 25 (5) pp 1-9
[7] AOAC 1995 Official Methods of Analysis of the Association of Official Analytical Chemists (Washington: AOAC)
[8] Narayana K and Narasinga-Rao M S 1984 Effect of partial proteolysis on the functional properties of winged pea (Psophocarpus tetragonolobus) flour J. Food Sci. 49 pp 944–7
[9] Eastman J E and Moore C O 1984 Cold-water-soluble granular starch for gelled food compositions U.S. Patent 4,465,702
[10] Sathe S K and D K Salunkhe 1981 Functional properties of the great Northern bean proteins: emulsion, foaming, viscosity and gelation properties J. Food Sci. 46 pp 71-81
[11] Lopulalan C G C 2008 Kajian formulasi dan isotermis sorpsi air biskuit jagung [Study of formulation and isotherms of corn biscuits water sorption] *Thesis* Postgraduate School, IPB University, Bogor

[12] Yu X, Yu H, Zhang J, Shao S, Xiong F and Wang Z 2015 Endosperm structure and physicochemical properties of starches from normal, waxy, and super-sweet maize *Int. Journal of Food Properties* **18** (12) pp 2825-39

[13] Dhingra D, Michael M, Rajput H and Patil R T 2012 Dietary fibre in foods: a review *J. Food Sci. Technol.* **49** (3) pp 255–66

[14] Raharja S, Paryanto I and Yuliani F 2004 Ekstraksi dan analisa dietary fibre dari buah mengkudu (*Morinda citrifolia*) [Extraction and analysis of dietary fibre from noni fruit (*Morinda citrifolia*)] *J. Tek. Ind. Pert.* **14** (1) pp 30-9

[15] Mancebo C M, Picón J and Gómez M 2015 Effect of flour properties on the quality characteristics of gluten free sugar-snap cookies *LWT - Food Science and Technology* **64** (1) pp 264–9

**Acknowledgement**

Authors want to thank Universitas Sumatera Utara for the support and funding this research as 2012 Development Research scheme, number:13/UN5.2.3.1/SP4/PPM/2012.