Conference Paper

Wheat Flour Substitution with Retrograded Banana Flour to Produce Cookies Possessing Good Physical Characteristics and Low Glycemic Index

Yana Cahyana and Resti Restiani

Laboratory of Food Chemistry, Food Industrial Technology Department, Universitas Padjadjaran, Indonesia

Corresponding Author:
Yana Cahyana
y.cahyana@unpad.ac.id

Received: 28 July 2017
Accepted: 14 September 2017
Published: 23 November 2017

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICSAFS Conference Committee.

Abstract

Diabetes Mellitus is one of degenerative diseases (DM) affecting many people around the world. It is thus important to prevent DM by choosing the right food with low in glycemic index (GI). Modified banana flour-based low GI cookies could be the solution in which the modification may be carried out by retrograding the flour. The purpose of this study was to determine the right proportion between retrogradated banana flour and wheat flour to produce cookies with low glycemic index and good characteristics. The method was randomized block design with six treatments and three time replications. The treatments were ratio (in percentage) of modified (retrogradated) banana flour with wheat flour 0:100, 50:50, 60:40, 70:30, 80:20, and 90:10. The result showed that cookies made of 90% retrogradated banana flour and 10% wheat flour was the best treatment with GI value of 57,20. Physical analysis comprised of hardness and lightness (L*) were around 1593.44 gF and 57,22, respectively.

Keywords: wheat flour, glycemic index, cookies, retrogradated banana flour

1. Introduction

Banana (*Musa paradisiaca*) has been known as an abundant fruit planted in Indonesia. Indonesia contributed for around 6.20% of banana world production and 50% of Asian banana production [1]. Banana production has steadily increased for the last 5 years. As much as 6.2 million tons of banana was produced in Indonesia in 2013 of which around 25% was harvested in West Java [2]. Banana, thus is a potential fruit capable of giving an economic impact to the society, particularly farmers and related stakeholders.

Banana possesses high carbohydrate content with starch content around 17,2-38% of which the amylose content ranges from 9.1 to 17,2% [3]. Therefore banana can be regarded as a good alternative source for starch. Raw banana starch consists of high content of resistant starch (type of RS2). Resistant starch is the fraction of starch which is not hydrolyzed to D-glucose in the small intestine within 120 min of being consumed, but which is fermented in the colon [4]. The starch has been believed to exert beneficial impact particularly on those suffered from diabetes mellitus (DM) since it results in lower glycemic index [5]. The resistant starch contained in raw banana starch, however, decreases during the processing due to gelatinization. It is thus important to modify the starch in order to maintain the high content of resistant starch. There are a number of methods to modify starch. Retrogradation is one of those available in the literatures.

In order to have an added value, banana needs to be further processed into various products such as banana flour-based cookies. The flour used in this study has been modified using retrogradation method so that its resistant starch content remained high. It is expected that using banana flour high in resistant starch, not only will it give economically an added value, but also exerts beneficial health effect to the society.

2. Materials and Method

The main raw material used in this study was green banana (variety of banana tanduk), categorized at maturity level 1. It was obtained from traditional market at Gede Bage, Bandung. Supporting materials were wheat flour, egg, sugar, margarine, sodium metabisulphite.

Modified banana flour was prepared from the banana with the process as follows: Banana was unpeeled and sliced into 3-5 mm thickness, then merged into NatriumThe main raw material used in this study was green banana (variety of banana tanduk), categorized at maturity level 1. It was obtained from traditional market at Gede Bage, Bandung. Supporting materials were wheat flour, egg, sugar, margarine, sodium metabisulphite.

Modified banana flour was prepared from the banana with the process as follows: Banana was unpeeled and sliced into 3-5 mm thickness, then merged into Natrium metabisulfit 300 ppm. The next step was merging in boiling water for 15 minutes, followed with storage at 4°C for 24h, oven drying at 50°C for 24h and then grinding with disc mill to obtain 80 mesh of banana flour.

Chemical compounds used for analysis were H_2SO_4, K_2SO_4, NaOH, $Na_2S_2O_3$, H_3BO, HCl, luff schoorl, alcohol 95% and hexane. Tools used in this study included oven with blower, disc mill, balance, cold storage, knife, mixer, oven for baking, bowl. Experimental method consisting of five treatments with three replications has been carried out in this study. Treatments were designed to reveal the effect of modified banana flour substitution for wheat flour on cookies characteristics. The treatments were

(A) modified banana flour:whear flour (%) = 50:50

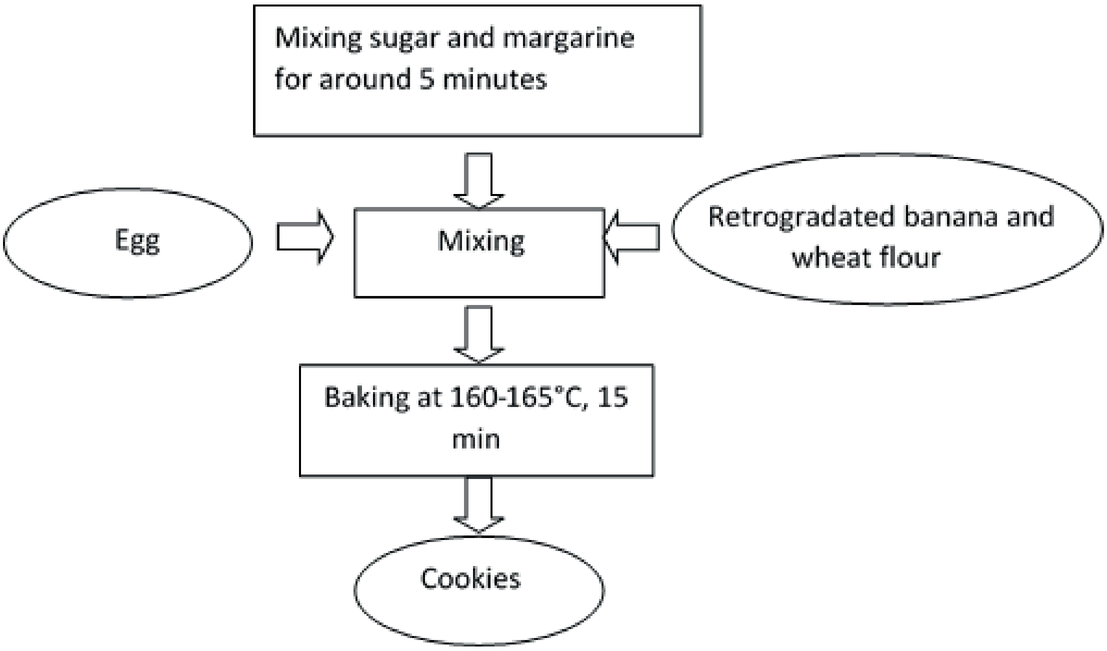

Figure 1: Flowchart of cookies preparation.

(B) modified banana flour:whear flour (%) = 60:40

(C) modified banana flour:whear flour (%) = 70:30

(D) modified banana flour:whear flour (%) = 80:10

(E) modified banana flour:whear flour (%) = 90:10

Control cookies made of 100% of wheat flour has been used. Cookies analysis included the analysis of glycemic index using in vivo method, texture analysis using texture analyser, colour using digital camera with CIELAB method. Cookies has been prepared as shown in the flowchart (Figure 1).

3. Result and Discussion

3.1. Glycemic Index

Glycemic index analysis was carried out in vivo using 18 male wistar mice in which every treatment of cookies feeding was applied to three mice. Prior to the experiment, the mice were firstly kept in a cage for the adaptation to the environment for 7 days and fed *ad libitum*. Temperature was kept at around 23-27°C and RH 60-65%.

Glycemic index taken from mice following cookies feeding is presented in Table 1. It is obvious that substitution of modified banana flour around 60% for wheat flour resulted in lower glycemic index. Cookies made of 100% wheat flour had glycemix

Table 1: The effect of banana flour substitution on Glycemic index of cookies.

Treatments	Modified banana flour: wheat flour (%)	Glycemic index
Control	0:100	77.09 ± 7.32^{a}
A	50:50	67.03 ± 6.71^{ab}
B	60:40	64.14 ± 1.57^{b}
C	70:30	62.09 ± 0.61^{b}
D	80:20	60.04 ± 1.20^{b}
E	90:10	57.11 ± 4.99^{b}

index of 77.1 while substitution with 60% of modified banana flour lowered significantly the GI to approximately 64. The higher substitution with modified banana flour, the lower glycemix index was. Substitution up to 90% of modified banana flour for wheat flour decreased further the GI to approximately 57.1. The decrease in glycemic index, however, was not significantly different compared to the substitution with 50% of modified banana flour.

Further analysis of carbohydrate absorption from cookies showed that for all feeding treatment, blood glucose level raised peak at 30 minutes following the feeding. As expected, the peak of blood glucose level was lowered in mice fed with cookies containing modified banana flour. The higher modified banana flour in the cookies, the lower the peak of blood glucose level at 30 minute was. This finding indicated that modified banana flour was effective in decreasing blood level, hence lower glycemic index.

Carbohydrate (specifically starch) in this study was modified physically where banana flour was heated and cooled repeatedly to result in resistant starch. Starch is hydrolyzed into dextrin and maltose by pancreatic enzyme and further broken down into glucose by enzyme present in small intestine [6]. The content of resistant starch in banana starch may prevent the digestive enzyme from hydrolyzing cookies starch, hence lower glucose level in the blood. This is an important finding and encouraging for those suffered from Diabetes Mellitus whose food is restricted to low glycemic index one.

3.2. Texture Analysis

Analysis of cookies texture was carried out using texture analyzer. The result is presented in Table 2. It is clear that the substitution of modified banana flour tends to lower cookies hardness. Substitution of banana flour at 50% decreased the hardness significantly. Further substitution of banana flour for wheat flour at 90% decreased

Table 2: The effect of modified banana flour modification on Cookies hardness.

Treatments	Hardness (gF)
Control	3100,89 ± 268,57 [a]
A (modified banana flour: wheat flour 50:50)	2358,99 ± 575,87 [b]
B (modified banana flour: wheat flour 60:40)	2357,87 ± 354,67 [b]
C (modified banana flour: wheat flour 70:30)	2270,54 ± 116,02 [b]
D (modified banana flour: wheat flour 80:20)	1886,54 ± 55,76 [bc]
E (modified banana flour: wheat flour 90:10)	1593,44 ± 386,64 [c]

significantly the hardness to 1593 gF compared to 100% wheat flour with the hardness of 3100gF.

Cookies hardness has been known to be affected by protein content of wheat flour. Wheat flour protein consisting of glutenin and gliadin is capable of forming elastic structure in the presence of water [7]. When the wheat flour is low, the hardness decreases. It is confirmed from this study that the substitution with modified banana flour decreased the hardness.

3.3. Cookies Colour

CIE-Lab method has been applied to measure cookies colour. The result which is presented as L* (lightness) value is tabulated at Table 3. The L* value ranges from 0-100 in which lower value indicates darker cookies and higher value indicates lighter one. The result showed that the use of banana flour to replace wheat flour affected the lightness of cookies. The increase in the substitution decreased the cookies lightness. Substitution at 50% decreased significantly the lightness to around 70 compared to cookies made of 100% wheat flour whose lightness was 93.98. Further substitution up to 90% lowered the lightness to around 57.22. The lightness at this substitution level was however not significantly different compared to the substitution with 70% modified banana flour.

The decrease in the lightness of cookies with the higher content of modified banana flour may result from the colour of modified banana flour used as raw material in this study. The banana flour colour was darker than wheat flour which was presumably caused by the enzymatic and non-enzymatic reactions during banana flour production. Cookies lightness may also result from reaction of Maillard and Caramelisation during baking.

Table 3: The effect of modified banana flour substitution on cookies lightness.

Treatments	Cookies Lightness (L*)
Control	93,98 ± 0,21[a]
A (modified banana flour: wheat flour 50:50)	70,35 ± 0,93[b]
B (modified banana flour: wheat flour 60:40)	63,37 ± 1,95[c]
C (modified banana flour: wheat flour 70:30)	61,37 ± 4,50[cd]
D (modified banana flour: wheat flour 80:20)	59,57 ± 2,54[cd]
E (modified banana flour: wheat flour 90:10)	57,22 ± 2,86[d]

4. Conclusion

The modified banana flour can substitute the use of wheat flour as raw material in cookies. The substitution at certain level decreased the glycemic index of cookies which is good for diabetes mellitus persons. The substitution also affected the texture and colour characteristics of cookies.

Cookies made of 90% modified banana flour and 10% wheat flour was considered as the best treatment with GI value of 57.20. Physical analysis comprised of hardness and lightness of cookies was around 1593.44 gF and 57.22 respectively.

Acknowledgment

This work was funded by Faculty of Agro-Industrial Technology, UNPAD (PNBP scheme) in 2015.

References

[1] Suyanti dan A. Supriyadi. 2008. Pisang, budidaya, pengolahan, dan prospek pasar. Penebar swadaya, Depok

[2] Badan Pusat Statistik (BPS). 2013. Fruits production in 2013. Available at: http://www.bps.go.id/ (accessible on 20 September 2014). Alipanah, M., L. Kalashnikova, and G. Rodionov. 2005. Kappa-Kasein genotypic frequencies in Russian breeds of Black and Red Pied cattle. Iran. J. Biotechnol. 3:191-194.

[3] Jenie, B.S.L., R. P. Putra, F. Kusnandar. 2012. Fermentasi Kultur Campuran Bakteri Asam Laktat dan Pemanasan Otoklaf dalam Meningkatkan Kadar Pati Resisten dan Sifat Fungsional Tepung Pisang Tanduk (*Musa paradisiaca formatypica*). Jurnal Pascapanen. 9 (1): 18 – 26.

[4] Tharanathan, R. N. 2002. Food-derived carbohydrates: Structural complexity and functional diversity. Critical Reviews in Biotechnology, 22(1), 65–84.

[5] [5] Zaragoza, E. F., M.J. Riquelme-Navarrete, E. Sánchez-Zapata, J.A. Pérez-Álvarez. 2010. Resistant starch as functional ingredient: A review. Journal Nutrition Reaserch and Nutritional 10: 1-12.

[6] Wardlaw, G. M., Hampl, J. S. 2007. Prespectives in Nutrition Seventh Edition. Mc Graw Hill, New York

[7] Koswara, S. 2009. Teknologi Pengolahan Roti. Available at: www.ebookpangan.com. Accessible on 5 March 2014.