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Life

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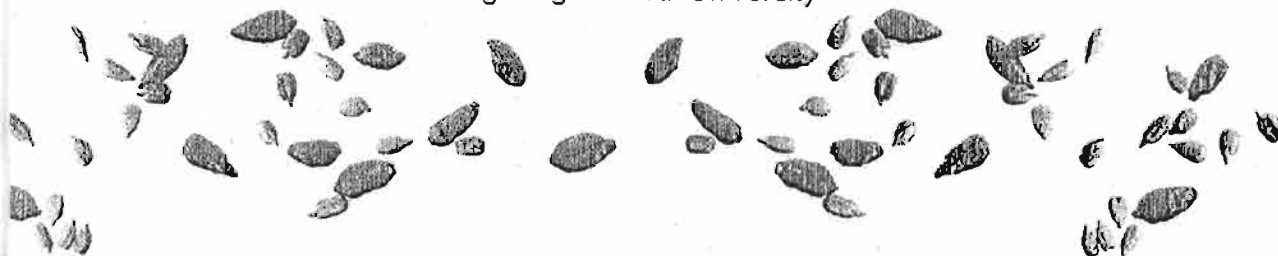
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Bogor Agricultural University



UTILIZATION OF MUNG BEAN AND RED KIDNEY BEAN AS FAT REPLACER IN RICE CAKE

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ABSTRACT

Rice cake is made from rice flour, eggs, margarines, baking powder and Na-CMC. Fat content in rice cake is high enough. High fat consumption can cause obesity so need the effort to reduce the amount of fat in cake formulation by using fat replacer. Mungbean (*Vigna radiata*) and red kidney bean (*Phaseolus vulgaris* L.) can be used as carbohydrate-protein-based fat replacer. The proportion of margarine and steamed bean (mungbean and red kidney bean) in rice cake can influence physicochemical properties of rice cake. The research aimed to observe the influence of proportion of margarine and steamed bean (mungbean and red kidney bean) on physicochemical properties of rice cake. Experimental design was Completely Randomized Block Design with one factor. The proportion of margarine and steamed bean consisted of six levels, namely 100%:0%, 80%:20%, 60%:40%, 40%:60%, 20%:80% and 0%:100% with four replications. The experiment of steamed mungbean and steamed red kidney bean were conducted separately. The results showed that the proportion of margarine and steamed (mungbean and red kidney bean) bean gave significant effect on moisture content, specific volume, and texture (hardness and springiness) of rice cake. The increasing of proportion of margarine to steamed bean would increase moisture content, specific volume and springiness value, but decreased hardness value of rice cake. This research recommended that mungbean and red kidney bean can be used as fat replacer in rice cake.

Keywords: fat replacer, mungbean, red kidney bean, rice cake

INTRODUCTION

Cake is one type of food product that preferred by consumers, ranging from children to adults. Rice cake is a cake that made of rice flour, eggs, margarine, baking powder, and Na-CMC. The use of rice flour as wheat flour substitute aims the cake can be consumed by people with gluten intolerance that cannot digest wheat flour based food product.

Rice cake is quite high in fat. Fat that used in rice cake making is margarine. Total fat content of rice cake theoretically amounts to 57.46 g/404.95 g of batter (14.19%). Fat plays an important role in cake making, which is related to volume, taste, texture, crumb cake reducing, color, and shelf life. Fat on the cake also provides softness on the cake, giving the nature of the moist cake, and make the cake easier to swallow (Pomeranz and Schellenbenger, 1971). High consumption of fat can lead to obesity and cause the emergence of several degenerative diseases such as heart disease and elevated levels of cholesterol in the blood. The use of fat replacer can be done to lower the fat content on rice cake.

Rudolph (1987) in Swanson (1996) mentioned, fat replacers were ingredients used in the food or the technology applied in food products to replace some portion or almost the entire amount of fat in food products without changing the taste and texture that consumers want. Fat replacer that used in rice cake is expected to can replace the function of fat without changing the physicochemical properties of rice cake. According to Hui (2006), fat replacer ingredients were classified into three types, namely carbohydrates based, proteins based and lipids based that can be used individually or in combination.

Beans contain high enough protein and carbohydrate so they can be used as carbohydrates and protein based fat replacer. Beans that can be used are mungbean (*Vigna radiata*) and red kidney bean (*Phaseolus vulgaris* L.). Mungbeans contain carbohydrates by 62.40% and protein by 22% (Rukmana, 1997). According to Sai-Ut et al. (2010), red kidney beans contained carbohydrates for 39.45% and protein for 17.37%. Proteins on mungbean and red kidney bean are known to have functional properties such as emulsifiers, foam forming capacity, water absorption, and oil absorption that can be used in food products. El-Adawy (2000) in Butt and Batool (2010) mentioned the ability emulsification mungbean protein isolate is quite high at 65% and 18% of stability. The ability to form foam on mungbean protein isolate is also quite high, ie $110 \pm 6.78\%$ (Butt, 2010). Foaming capacity on red kidney bean protein isolate is 53% and 62% of stability. Emulsification ability of red kidney bean protein isolates is $48.80 \pm 1.19\%$ and $36.33 \pm 1.16\%$ of stability (Sai-Ut et al., 2010). Protein component and carbohydrate component which is dominated by starch and in both types of beans will interact and produce functional properties on mungbeans and red kidney beans. Functional properties of that beans can be used to replace the role of fat (margarine) in rice cake making.

Mungbeans and red kidney beans used in rice cake making is steamed beans form. Starch and protein components in raw beans are structurally tied up with other components in complex form. The complex form of starch and protein components provide the beans characterize the functional properties when they applied to food products. Steaming is needed to break the structural conformation thus increasing their functional properties.

Steaming has an important role to changes in chemical structure of food product. Steaming can lead to hydrolytic activity due to high temperatures which causes chemical bonds breaking and chemical degradation thereby increasing the digestibility of food (Suhardi, 2010). Steaming can change the structure of the plant cell wall materials and modifying the food matrix. Steaming has a close relation with the structural changes of polysaccharide. Water vapor from steaming process will gelatinize starch thus increasing digestibility of nutrients (Booth et al., 1999). Steaming able to degrade the chemical compounds and break chemical bonds is a key change in the protein structure. According Uzogara and Ofuya (1992), steaming also aims to eliminate the toxicity of proteins and inactivate antinutrient factors, such as trypsin and amylase inhibitors that are usually found in beans.

The steaming of mungbeans was done for 5 minutes while the steaming of red kidney beans performed for 15 minutes. The time difference is due to differences in the level of beans hardness. Steaming beans also aims to facilitate the process of grinding the bean so that steamed bean can be mixed well in the rice cake batter.

The use of steamed beans as a fat replacer were done by reducing the use of margarine in cake rice formula. The proportion of margarine and steamed beans studied were 100%:0%, 80%:20%, 60%:40%, 40%:60%, 20%:80% and 0%:100%. The research aimed to study the effect of the proportion of margarine and steamed beans on the physicochemical properties of rice cake.

METHODOLOGY

Materials

Rice cake making materials consisted of rice flour, eggs, sugar, margarine, Na-CMC (Natrium Carboxymethyl Cellulose), low-fat milk, baking powder, mungbeans and red kidney beans. The materials were obtained from the local market.

Experimental design

Experimental design was Completely Randomized Block Design with one factor. The proportion of margarine and steamed bean consisted of six levels, namely 100%:0%, 80%:20%, 60%:40%, 40%:60%, 20%:80% and 0%:100% with four replication. The experiment of steamed mungbean and steamed red bean were conducted separately. Data were analyzed using Analysis of Variance at $\alpha =$

0.05 and Duncan Multiple Range Test at $\alpha = 0.05$ if there was significant difference between treatments.

Steamed beans preparation

Mungbeans and red kidney beans each soaked for 12 hours (ratio of bean : water = 1: 5). Epidermis was peeled and peeled 100 g wet beans steamed for 5 minutes for mungbeans and 15 minutes for red kidney beans. Then steamed bean was grinded with mortar before the grinding continued with a dry mill (Phillips).

Rice cake making

Rice cake was made with following formulation: 180 g of egg whites, 65 g of egg yolks, 55 g of sugar, 10 g of low-fat milk, 2.2 g of Na-CMC, 55 g of rice flour, 2.75 g of baking powder and 45 g of liquid margarine. Steamed bean was used to replace the margarine according to treatment and the total weight of margarine and steamed bean was 45 g. Eggs (white and yolk), sugar, low-fat milk, Na-CMC and steamed beans mixed with a mixer (Bosch) at speed 1 for 15 seconds and then continued with speed 2 for 3 minutes. This stage ended when formed a solid and stable foam. Rice flour was mixed with baking powder and the batter stirred entered manually. Stirring was done quickly and one direction so that the batter was mixed homogeneous and foam that has formed not collapse due to loose too much air. Liquid margarine was added little by little while stirring manually. The batter was immediately poured to the baking pan (20 x 20 x 4 cm³) that lined with baking paper. Baking oven (NAYATI) carried out at a temperature of 175°C and for 25 minutes. Rice cake then cooled at room temperature (about 1 hour) prior to analysis.

Physicochemical analysis

Moisture content was determined by thermogravimetry method (AOAC, 2006). The specific volume was the ratio between the volume of rice cake (cm³) with rice cake weight (g). The volume of rice cake was determined by seed displacement method using barley (Lopez et al., 2004). The texture (hardness and springiness) were measured by texture analyzer (TA-Xt Plus) using a 75 mm diameter cylindrical probe with a test speed of 2.0 mm/s (modification of Gomez et al., 2007).

RESULT AND DISCUSSION

Moisture content

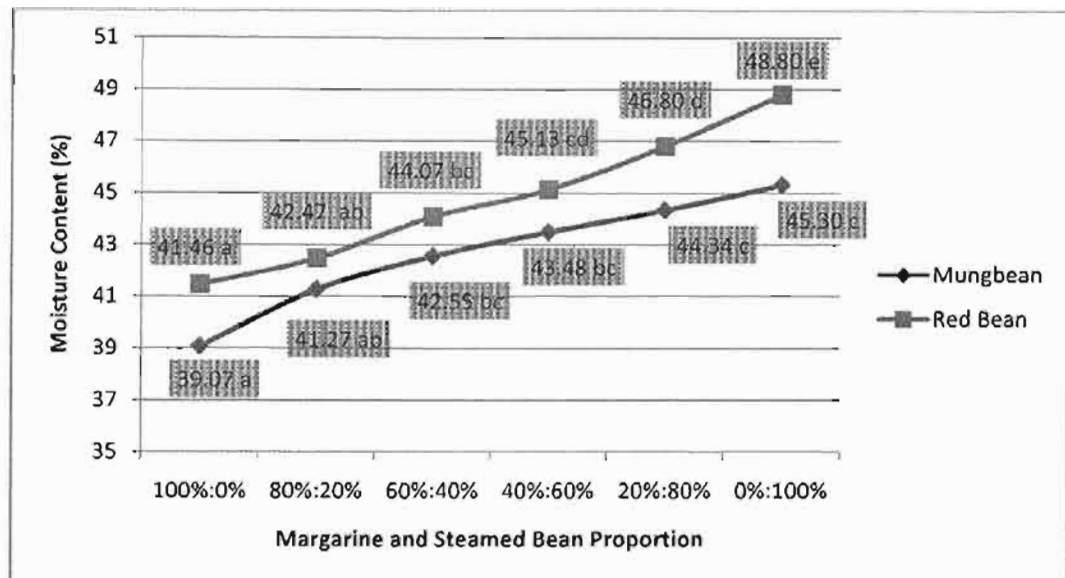
Moisture content is one of parameters that affect of the rice cake quality. Moisture content was determined by thermogravimetry method. The measured moisture content is the amount of water that released from rice cake when dried in the oven. According to Winarno (2002), released water consists of weakly bound water that forms hydrogen bonds with macromolecules and free water contained in the space between cells and intergranular.

The results showed that the rice cake moisture content ranged from 39.07% to 48.80%. ANOVA results at $\alpha = 5\%$ showed that the proportion of both margarine and steamed mungbeans or red kidney beans significantly affected on the moisture content of rice cake. The relationship between the proportion of margarine and steamed bean with moisture content and the results of DMRT at $\alpha = 5\%$ are in Figure 1.

The difference in the proportion of margarine and steamed bean significantly affected on the moisture content of rice cake. The beans were used as a fat replacer either mungbeans or red kidney beans were steamed beans. Steaming caused the beans absorb water and increased the moisture content of steamed bean. It would increase the moisture content of rice cake.

Water absorption by steamed bean occurred due to changes in the structure of its main components, namely starch and protein. According to Zayas (1997), steaming beans make starch-

protein complex in beans distantly space so starch will be gelatinized and protein will be denatured. Gelatinization of starch will increase water uptake by steamed bean. Denaturation of protein cause polypeptide structure unfold and interaction between proteins of beans and water through hydroxyl group, which will also increase water uptake by steamed bean.



Means accompanied by the same letter on the same line do not present a statistically significant difference ($\alpha=0.05$) according to DMRT's test.

Figure 1. Relationship of Margarine and Steamed Bean Proportion with Moisture Content of Rice Cake

Starch and protein in steamed bean will interact with starch from rice flour, protein from eggs, and Na-CMC to form the starch-protein matrix. Starch granules and protein during baking will be gelatinized and denatured further. According Mwangwela (2006), during the process of gelatinization, starch granules absorb water and swell. Starch and protein will interact via hydroxyl group to form a complex (gel matrix). The presence of heat will cause the starch-protein matrix trap water stronger and not easily released. The stronger bonding of starch and protein in rice cake, the higher the ability to trap water, so with the addition of steamed beans increased, the amount of water retained during baking process would be more.

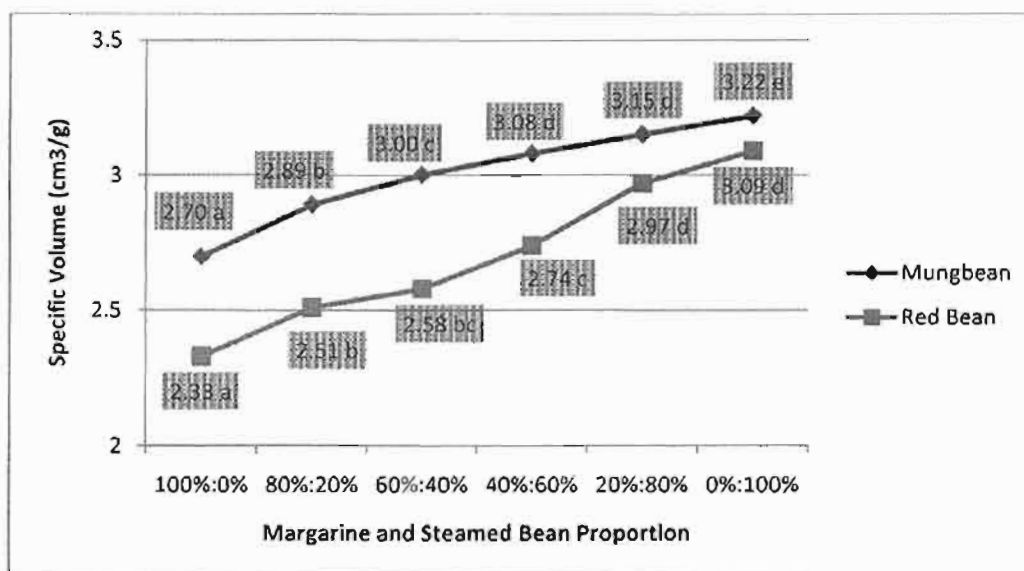
Specific volume

The specific volume is ratio between volume of rice cake (cm^3) with rice cake weight (g). Comparison between volume and weight of rice cake can determine the amount of volume per unit weight of rice cake so it can determine its mass density.

The volume of cake is derived from trapped air during mixing (Desrosier, 1988). The volume of rice cake was originally determined by mixing the eggs, sugar, and Na-CMC. The presence of trapped air during mixing of egg (white and yolk) causes the formation of foam. Sugar can increase the stability of foam. Na-CMC can increase the viscosity of rice cake batter because Na-CMC have hydrophilic group that binds water in batter through hydrogen bonding with hydroxyl groups of starch and form a helix conformation. This bond will form three-dimensional structures when binding with other macromolecules. Na-CMC matrix has extensibility that can retain gas expansion during baking process and strengthen the structure of coagulated egg proteins. Thus Na-CMC has a role in forming of rice cake volume.

The results showed that specific volume of rice cake ranged from 2.70 to 3.22 cm^3/g . ANOVA results at $\alpha = 5\%$ showed the proportion of margarine and steamed beans significantly affected on

specific volume of rice cake. The relationship between the proportion of margarine and steamed bean with specific volume of rice cake and the DMRT results at $\alpha = 5\%$ are in Figure 2.



Means accompanied by the same letter on the same line do not present a statistically significant difference ($\alpha=0.05$) according to DMRT's test.

Figure 2. Relationships of Margarine and Steamed Bean Proportion with Specific Volume of Rice Cake

The use of steamed beans will increase the amount of starch and protein components in rice cake batter. Gelatinized starches and denatured proteins in steamed beans will affect the functional properties of steamed bean like foam formation capacity, foam stability, emulsion formation capacity and emulsion stability. The functional properties have a role in making rice cake batter which ultimately will affect the volume of rice cake.

The use of steamed beans can increase the formation of foam on making cake batter due to its protein component. Legowo (2007) suggested that the foam formation mechanism based on the mechanism of soluble protein that reached the interface between water and air through diffusion, concentration, surface tension and the change of polypeptide structure based on the degree of polarity. The increasing of foam forming showed more trapped air. Starch component of steamed bean have a role in foam stabilization. Gelatinized starch will increase the viscosity of foam interface layer so that the foam becomes more resistant to collapse.

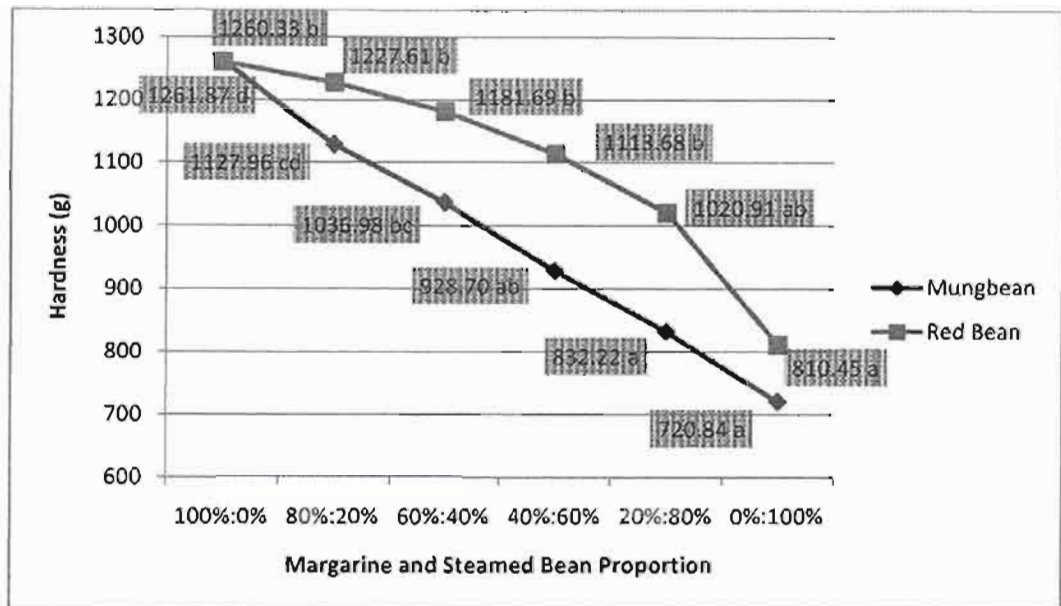
Denatured proteins and gelatinized starches also provided the increasing of emulsions formation and emulsion stability in rice cake batter. Yada (2004) mentioned proteins can act as emulsifiers. This is due to the protein has a hydrophobic group that can bind to lipids that are non-polar and hydrophilic groups that can bind to water that is polar. Starch has a role to stabilize the emulsion by increasing the viscosity of the dispersing medium so that a stable emulsion is formed.

The increasing of steamed bean proportion will increase the formation of foam and emulsion in the rice cake batter so that the air is trapped more and more. The trapped air will expand during baking. The expansion caused rice cake volume becomes larger with increasing of steamed bean proportion.

Hardness

According Roshental (1999), the value of hardness is shown by the peak value after the product is pressed for the first time. The higher the hardness value means the greater the force (g) required to suppress the product, so the harder the product. Measurement of hardness on the rice cake aimed to observe the influence of the proportion of margarine and steamed bean on rice cake hardness.

The results showed that rice cake hardness values ranging from 780.842 g to 1261.868 g. ANOVA results at $\alpha = 5\%$ showed the proportion of margarine and steamed bean affected significantly t on hardness of rice cake. The relationship between the proportion of margarine and steamed bean with rice cake hardness and the results of DMRT at $\alpha = 5\%$ are in Figure 3.



Means accompanied by the same letter on the same line do not present a statistically significant difference ($\alpha=0.05$) according to DMRT's test.

Figure 3. Relationships of Margarine and Steamed Bean Proportion with Hardness of Rice Cake

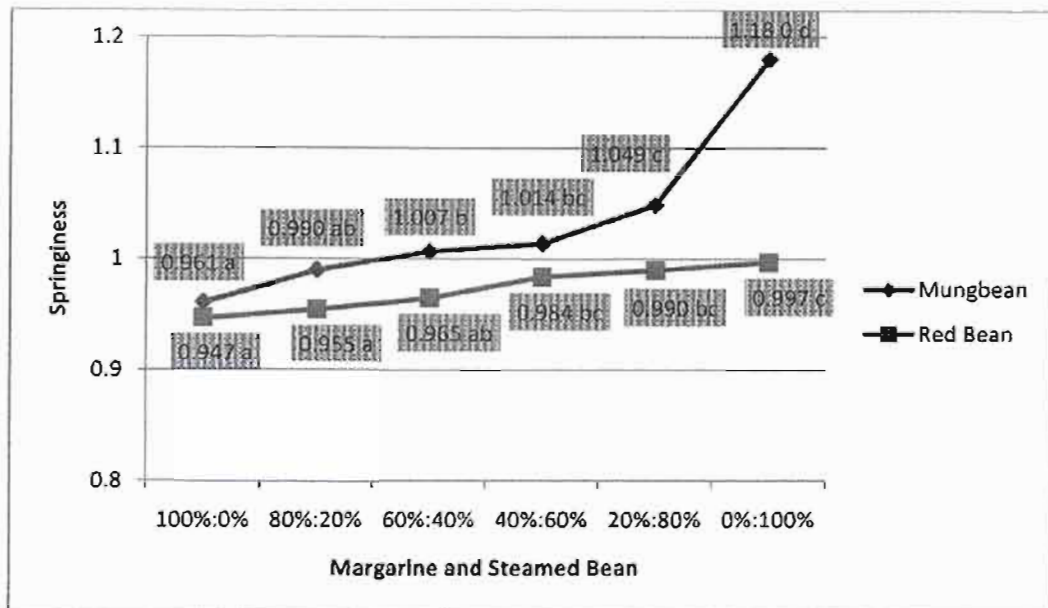
Denatured protein and gelatinized starch on steamed beans can increase the ability of the dough to form a foam. This caused the increasing of trapped air amount. During baking, the trapped air would expand, but the ability of starch-protein matrix in retain the air expansion decreased due to the presence of other components that interfere with steamed bean starch-protein matrix extensibility in retaining the expansion of air. This caused the starch-protein matrix wall rupture and merger cell from one cell with another cell so that the rice cake pores are not uniform. The number of pores that much and do not uniformly showed rice cake structure is not firm so the force required to press rice cake become lower along with an increase in steamed bean proportion, in other words the hardness value decreased.

Rice cake hardness is inversely proportional to the specific volume of rice cake. The higher the specific volume of rice cake, then the lower the hardness value. Specific volume indicates that the greater the height of the rice cake is increasing. The pores were formed on the rice cake will increase and not uniform. This caused the value of rice cake hardness decreased.

Springiness

Springiness is the ability of a food product to return to first form after a given pressure (Roshental, 1999). Springiness value is the ratio between the first pressure and the second pressure given on the rice cake. Measurement springiness on rice cake aimed to observe the influence of margarine and steamed bean proportion on rice cake springiness.

The results showed the value of springiness rice cake ranged from 0.961 to 1.180. ANOVA results at $\alpha = 5\%$ showed that the proportion of margarine and steamed bean significantly affected on rice cake springiness. The relationship between the proportion of margarine and steamed bean with rice cake springiness and the results of DMRT at $\alpha = 5\%$ are in Figure 4.



Means accompanied by the same letter on the same line do not present a statistically significant difference ($\alpha=0.05$) according to DMRT's test.

Figure 4. Relationships of Margarine and Steamed Bean Proportion with Springiness of Rice Cake

Springiness influenced by the addition of steamed beans in rice cake batter. Protein and starch components in steamed bean able to maintain the foam and emulsion of cake batter. This caused the increasing of trapped air amount. The trapped air would expand during baking so that the starch-protein matrix walls getting thinner. This made the rice cakes become soft.

CONCLUSION

The proportion of margarine and steamed (mungbean and red kidney bean) bean gave significant effect on moisture content, specific volume, and texture (hardness and springiness) of rice cake. The increasing of proportion of margarine to steamed bean would increase moisture content, specific volume and springiness value, but decreased hardness value of rice cake. This research recommended that mungbean and red kidney bean can be used as fat replacer in rice cake.

ACKNOWLEDGEMENT

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PROGRAM (TENTATIVE)

DAY 1: Wednesday, October 15, 2014
Registration
Joint Opening Ceremony-FIA Exhibition & Conference 2014
Welcome Remarks - Director of SEAFast Center
Message from President of IAFT
Keynote Speech: The Role of Food for a Quality Life
Morning Break and Posters/Display Viewing
PLENARY 1. Innovations in Food Processing (10.30 - 12.30)
Innovative Food Processing Line
Nano Technology
Cold Chain Technology
Shelf Stable Foods
Break and Posters/ Display Viewing
PLENARY 2. Novel Approaches in Food Safety and Quality (13.30 - 15.30)
Latest Issues in Food Safety: Chemicals in Food
Ensuring Beverages Quality and Safety
Pathogen Detection
Break and Posters/Display Viewing
PARALLEL SESSION (15.30 - 17.10)
Parallel Session 1, 2, 3 & 4
Adjournment Day 1
SPECIAL EVENTS (15.30 - 21.00)
Graduate Students Research Paper Competition
PATPI's Congress (for member only)

DAY 2: Thursday, October 16, 2014
PLENARY 3. Advances in Nutrition & Health (08.30 - 10.30)
Infant Nutrition, Lactating Mother
Supplement/Jamu
Health Food
Food Ingredients
Morning Break and Posters/Display Viewing
PLENARY 4. Emerging Food Issues (10.30 - 12.30)
Sustainable Agriculture: Producing More Using Sustainable Resources
Food Trade: ASEAN Economic Community
Fuels vs Foods
Break and Posters/ Display Viewing
PARALLEL SESSION (13.30 - 15.30)
Parallel Session 1, 2, 3 and 4
Break and Posters/ Display Viewing
SPECIAL EVENTS (15.30-17.10)
FIFSTA Meeting
Closing Remarks - Director of SEAFast Center

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INTRODUCTION

Ensuring the quality and safety of our food is fundamental for the healthy, wholesome and quality life of every individual, significantly contributing to the development of national and global growth. This is the underlying reason that drives today's food practices, manufacturing, trade, research and regulations to prepare and pave the way to meet emerging challenges and issues of tomorrow. Issues of climate change, burdening population, changing lifestyles, health and diseases are immediate and materializing in an unprecedented rate that forces us to ask how we can continue to provide safe and nutritious food for a quality life.

Solving immediate and emerging challenges of the future of our food requires interdisciplinary and multidirectional approaches involving all sectors involved: corporates, governments, academics and the public. Substantial questions and problems to be addressed are found and continue to emerge in all points of the food chain, from farm to table, thus requiring the meeting and contribution of all parties involved.

This International Conference will be the venue where results of recent research developments, trade and business advances, and all other food related issues and ideas are discussed and exchanged involving all parties involved in driving the global food production. Corporate, governments, academics and the general public are welcome to participate and join the discussion. This is one of the agendas of Indonesian Association of Food Technologists (IAFT/PATPI), the Department of Food Science and Technology (DFST-IPB), and Southeast Asian Food and Agricultural Science and Technology (SEAFST) Center-IPB to organize this two-day conference on 15-16 October 2014. This conference is held in conjunction with Food Ingredients Asia 2014.

OBJECTIVE

This international conference program discusses food science and technology as well related issues which will influence people's quality life.

VENUE

Conference will be held in Jakarta International Expo Kemayoran, Jakarta - Indonesia.

PARTICIPANTS

Scientists, industry practitioners, professionals, government officers working in the area of food, food safety, and food trade are encouraged to participate updating themselves with the latest development of food science and technology for a quality life.

LANGUAGE

The official language of the conference is English.

Call for Abstract

Submit abstracts (max 300 words) in MS Word format. Deadline for abstract submission is **July 8, 2014**. Please submit your abstract via e-mail to: seafastseminar@gmail.com

REGISTRATION FEE

	Within September 26, 2014	After September 26, 2014
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Academicians/Researchers/Government officers/NGO	Rp. 750.000	Rp. 900.000
Industries	Rp. 1.300.000	Rp. 1.650.000
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REGISTRATION FORM

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15 - 16 October 2014
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