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Optimasi Formula Produk Ekstrusi Berbasis Rasi Sebagai Pangan Pokok Alternatif

Formulation of Rasi-based Extrusion Products as an Alternative Staple Food

Marleen Sunyoto[1*)] and Tri Yuliana[1)]

1Faculty of Agriculture Industrial Technology, Padjadjaran University,
Jatinangor 40600, Indonesia
*)emhaer@yahoo.co.id

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ABSTRACT

Rasi, a cassava-derivative product,contains high concentration of starch so it can be utilized as extrusion products.Its low protein content will be overcome by the addition of protein from maize, groats and mung beans. The purpose of this study was to obtain the appropriate formula from the combination betweenrasi and corn flour, rasi and rice groats flour andrasi and mung bean flour, to produce extrudate, having physical, chemical and sensory characteristics that preferred most by panelists. The resulting extrusion product is expected to become a model of an alternative local food-based staple food. The research method used was Randomized Block Design (RBD) with 6 treatments and 4 repetitions. The study showed thatrice frommixed rasiflour andrice groats belongs to the group of low amylose content (10-20%), resulting in a softer rice (fluffier) comparedwith rice derived from acombination of rasi flour and corn flour or rasi flour and mung bean flour thatcan begrouped into moderate amylose level (20-24%). Mixed rasi flourand mung bean flour produce extrudates with the highest protein content of 22%, whereasmixed rasi flour and corn flour produce the highest fat content. The Influence of rehydration was the highest atthe mixed rasi flour and mung bean flour, while mixed rasi flour andrice groats generate the lowest rehydration power.

A B S T R A K

Rasi, produk ekstruksi turunan singkong mengandung konsentrasi pati yang tinggi, dapat dikonsumsi sebagai pilihan makanan pokok yang memiliki energi 359 Kcal/100 g tetapi rendah protein. Penambahan protein dari jagung, menir, dan kacang hijau kedalam produk diharapkan dapat mengatasi rendahnya kadar protein. Penelitian ini menggunakan metode eksperimen rancangan acak kelompok (RAK) dimana 6 rasio perlakuan terdiri dari bahan campuran pada 4 ulangan dibuat untuk menghasilkan ekstrudat, memiliki sifat fisik, kimia dan sensori yang paling digemari oleh panelis, yaitu perbandingan rasi-tepung jagung sebesar 85:15 dan 70:30, perbandingan rasi-tepung menir sebesar 50:50 dan 55:45, dan perbandingan rasi-tepung kacang hijau sebesar 70:30 dan 65:35. Hasil penelitian menunjukkan bahwa campuran rasi-tepung menir termasuk kedalam golongan rendah amilosa (10-20%), menghasilkan beras yang lebih lembut (pulen) dibandingkan dengan campuran turunan dari rasi-tepung jagung dan rasi-tepung kacang hijau yang tergolong kedalam tingkat amilosa sedang (20-24%). Campuran rasi-tepung kacang hijau menghasilkan ekstrudat dengan kandungan protein tertinggi sebesar 22% sedangkan campuran rasi-tepung jagung menghasilkan kandungan lemak tertinggi. Pengaruh rehidrasi adalah tertinggi di campuran rasi-tepung kacang hijau sementara itu campuran rasi-tepung menir menghasilkan kemampuan rehidrasi terendah.

Introduction

Background

High dependency on rice consumption pattern gives rise to the problems in national food security. Each year rice consumption of Indonesian people reaches 139.15 kg/capita (BPS, 2011). Rice demand is currently around 34 million tonnes/year. Effort has to be done to reduce this high consumption by replacing rice with other carbohydrate foods.

Cassava is a food source of carbohydrate, so it could potentially be used as cassava food alternatives to reduce rice consumption.Utilization of cassava also needs to be done in order to improve the utilization of local food resources that could potentially improve food sovereignty. Utilization of cassava has not been maximized carried out by looking atit'ssimple processing and untouched technology. People can be motivated to accept cassava as their staple food by creating cassava-based product with a shape resembling rice.

Institute of Agricultural Technology Assessment has made artificial rice by using corn starch and cassava as raw materials. Artificial rice has a chemical composition similar to rice except thatit's carbohydrate content ismuch higher than rice, ranging from 81.3 to 83.9%. Moreover, artificial rice can be easily damaged in raw form.

Previous experiment showed thata cassava-based product can be formed into rice grain shaped, by using extrusion machinery. Cassava has a high starch content, of up to 90%, making it suitable to be used as an extrusion products [1]. Starch content and and the ratio of amylose to amylopectinin the raw material will affect the properties of extruded products. *Rasi*has an energy content of 359 kcal/100 gram material that almost equivalent to rice, whereas rice contains energy of 360 kcal/100 gram material, so that *rasi* can be used as an alternative source of carbohydrate foods other than rice. However, protein content of *rasi*is low, only 1.4 grams in 100 grams of material. Therefore, to improve the nutritional value of those rice grain-shaped, extrusion products, additional materials such as corn, rice groats and mungbeans are used.

Based on the description's above, study on the characteristics of the physical, chemical and sensory by formulatingthe appropriate ratio of corn flour, rice groats and mung beans flour to produce extruded, rice grains-shaped of new product that meet the common standard and accepted by consumers.

Objectives

The aim of this research is to detemine the appropriateformulaof *rasi* to corn flour ratio; *rasi* to rice groats and *rasi* to mung bean flour to produce extrusion product with good physicochemical characteristics, having a rice grain shape and preferred by panelists and consumers.

Theoritical Background

Rasi is one of food sources rich in carbohydrates derived from solid waste cassava in tapioca or starch processing. Due to it's highly carbohydrate content, itis utilized as a staple food to substitute rice byindigenous people live in Cireundeu Village, South Cimahi District, West Java. *Rasi*grain has 1-2 mm size, white and can be retained for up to three months.It is a solid product derived from squeezing or sieving freshly grated cassava. Dietary fiber is part of cell that can not be digested by human digestive enzymes, so that it can not be absorbed by the intestine.

Corn that contains enough nutrients and fiber is adequate to serve as staple food to substitute rice or mix with rice. Nutrients content in corn per 100 grams of material is 355 calories, 73.70 grams carbohydrates, 9.20 grams of protein and 3.90 grams of fat.

Rice groats are the result of rice processingin rice mill, just like broken rice, but groats are smaller than broken rice about 0.2 parts of intact rice.Indonesian Logistic Agency (BULOG) describesthat rice groats can pass through the 2.00 mm sieve. The main product of rice milling is 60-66% rice, 8-12% rice bran and 5-8% rice groats. In general, rice with groats shaped is easier to be process in extrusion machine. Groats contain starch 85 to 87.8%.

Mung beans contain about 62.5% of carbohydrate component which is the largest component compared to other components, so it can be used as an energy source. Carbohydrates composed of starch, sugar and fiber.Mung beans are also a source of protein, calcium and phosphorus that are beneficial to bone. Unsaturated fatty acids content in mung beans is good for those suffering from obesity to lose weight. It also contains Vitamin B1, the coenzyme that plays an important role in the oxidation of carbohydrates to convert into energy. Vitamin B2 in mung beans can help the absorption of protein in the body.

Products resembling grains of rice is one of the products referred to as extrusion products or extrudates. The extrudate is food that made through extrusion process from raw materials of flour or starch with the addition of other foods with or without going through the frying process. The advantageof extrusion method in cooking process is high productivity, low production costs, typical product shaped, more varied products eventhough coming from the same raw materials, high-quality products.

Method

The materials used were rasiof Karikil varieties from Cireundeu, West Java, corn flour, rice groats Ciherang, West Java,mung bean of Swallow varieties, and mineral water. The tools used in this experiment is single screw extruder, plastic measuring cups, scales, plastic containers, sieves, gas stove, spoon, pan, boiler, electric oven cabinet-type, dryer,infra red thermometer and tacometer.

The research method used was experimental method using a Randomized Block Design (RBD), consisting of 6 treatments and 4 repetitions. The experiment was the formulation of the ratio of rasi torice groats, rasi to corn flour and the ratio ofrasi to mung bean flour with the

following details: A: Rasi : Corn Flour = 85: 15; B: Rasi : Corn Flour = 70: 30; C: Rasi : Rice Groats = 55: 45; D: Rasi : Rice Groats = 50: 50; E: Rasi : Mung bean Flour = 70: 30; F: Rasi : Mung bean Flour = 65: 35

The study was conducted in two stages, the preliminary research and primary research.

Preliminary Research

Preliminary research was to establish treatments that used in the main study. Research stages were as follows: determination of water content of the dough, determination of the ratio of materials to be used,determining the method of cooking and determination of the amount of water added during cooking.

Main research

Based on the results in the preliminary studies, extrusion product or extrudates were made by varying the ratio of *rasi*to corn flour, *rasi* to rice groats and *rasi* to mung bean flour. Following this, the physical and chemical analysis and organoleptic tests were performed on the extrudate. Stages of making extrudates with rice grain formwere as follows :Weighing, Mixing, Extrusion, Drying, Cooking, Hedonic test on the organoleptic results of extrudates

Results and Discussion

Amylose Content

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significanteffect on the resulting amylose content of extrudate. Results of the statistical test on the effect of treatment on the amylose content of extrudate can be seen in Table 1.

Table 1. The Influence of Various Treatments on the Amylose Content

Treatments		Average Value of Amylose Content (%)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	20.54	a
	B: 70 : 30	21.87	a
Rasi : Rice Groats	C: 55 : 45	18.1	b
	D: 50 : 50	18.23	b
Rasi : Mung bean Flour	E: 70 : 30	21.2	a
	F: 65 : 35	20.24	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Mixed *rasi*with rice groats gave lower amylose content than four other treatments, whereas mixed *rasi*with corn flour gave a higher amylose content.*Rasi* has 22.32% of amylose content because *rasi* is a food product, resulted fromseparation of starch from its raw material and then dried [2]. Amylose content of corn flour used in this research was 35.53, whereas amylose content of rice groats was 21.8%.Amylose is a fraction of dissolved starch, and starch is the most important element in rice because it affects the process of gelatinization. A number of alcohol and iodine of amylose complex-forming with fat can change the gelatinization temperature, texture and viscosity profiles of starches pasta [3].Starch can determine the physicochemical properties of rice and affect the quality and texture of the rice produced [4].

Amylose levels that are too high or too low can make the boiled rice becomes too hard or too soft. Boiled rice from mixed *rasi*and rice groats belong to the low amylose content (10-20%), while boiled rice from mixed *rasi*and corn flour or mung bean flour belong to the moderate levels of amylose (20-24%) [5]. Low amylose rice will give a softer rice (fluffier) than medium amylose rice. Indonesian people in general like boiled rice at moderate level (19-23% amylose content) with its texture moderate tosoft [6].

Protein Content

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting protein content of extrudate. Results of the statistical test on the effect of treatment on the protein content of extrudate can be seen in Table 2.

Table 2. The Influence of Various Treatments on the Protein Content

Treatments		Average Value of Protein Content (%)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	2.58	f
	B: 70 : 30	3.79	e
Rasi : Rice Groats	C: 55 : 45	4.56	d
	D: 50 : 50	5	c
Rasi : Mung bean Flour	E: 70 : 30	7.88	b
	F: 65 : 35	9.13	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Mixed *rasi* with mung beans flour produce extrudates with the highest protein levels, while mixed rasi with corn flour produce extrudates with the lowest protein content. It is because of these three materials used, the mung beans have the highest protein of 22%. Actual protein content of corn was higher (9.6%) compared to rice groats (8.67%), but in formulations, more rice groats were used than the corn flour so that the protein extrudates with *rasi* and rice groats will be higher than *rasi* with corn flour.

The production of rice grain-shaped extrudate will involve a number of thermal energy, such as heat generated from friction between materials with the extruder barrel as well as the drying process.

The presence of a high temperature resulted in the broken of intramolecular bond of proteincausing denatured protein. Denaturation lead to the damage of the bonds that make up the configuration of the protein molecule [7]. The heating will relatively loweringprotein levels so that the protein content of the extrudate will be lower than the raw material [8].

Moisture Content

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate did not give significant effect on the resulting water content of extrudate. Results of the statistical test on the effect of treatment on the water content of extrudate can be seen in Table 3.

Table 3. The Influence of Various Treatments on the Moisture Content

Treatments		Average Value of Moisture Content (%)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	6.55	a
	B: 70 : 30	6.19	a
Rasi : Rice Groats	C: 55 : 45	7.41	a
	D: 50 : 50	6.78	a
Rasi : Mung bean Flour	E: 70 : 30	6.5	a
	F: 65 : 35	6.47	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

The moisture content of the resulting extrudatewas ± 6-7%. Theaverage value of the water levels were not different due to the time and temperature of drying wet extrudates is the same at 60 º C for 18 hours, besides, prior to extrusion and drying process, the water content of the dough was also conditioned of up to 45%. The uniform conditions cause the amounts of evaporated water in the drying process is not too different.

Table 1 and 3 show that mixed*rasi* with rice groats has the lowest amylose content than other treatments. This causes the water holding capacity of starch increased so that the amount of water on the material surface becomes lower. At the time of drying, water on the surface and inside the starch granules will evaporate. The initial drying occurs on the surface of the water, after the water at the surface is reduced then there is the drainage of water from the material to the surface, because the balance of water in the material itself [8]. This causes the extrudate with a mixture of *rasi* with rice groats have a higher water content.

Fat Content

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting protein content of extrudate. Results of the statistical test on the effect of treatment on the protein content of extrudate can be seen in Table 4.

Table 4. The Influence of Various Treatments on the Fat Content

Treatments		Average Value of Fat Content (%)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	0.45	b
	B: 70 : 30	0.8	a
Rasi : Rice Groats	C: 55 : 45	0.25	d
	D: 50 : 50	0.32	c
Rasi : Mung bean Flour	E: 70 : 30	0.18	e
	F: 65 : 35	0.23	d

Note : The average value of treatment indicated by different lettersdiffer significantly, expressed at 5% level test according to Duncan Test.

Of the sixth treatment, mixed *rasi*with corn flour produces extrudate with the highest fat content. However, compared to rice that has ± 0.92% fat content, the sixth treatment produces extrudates with a lower fat content than rice. High fat content causes high complex bond of starch and fat so that the chance of the formation of fat

layer is higher resulted in poor absorption of water by the product when rehydrated [9].

Rehydration Power

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting rehydration power of extrudate. Results of the statistical test on the effect of treatment on the rehydration power of extrudate can be seen in Table 5.

Table 5. The Influence of Various Treatments on the Moisture Content

Treatments		Average Value of Rehydration Power (%)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	146.57	a
	B: 70 : 30	130.6	b
Rasi : Rice Groats	C: 55 : 45	112.97	c
	D: 50 : 50	104.64	c
Rasi : Mung bean Flour	E: 70 : 30	149.42	a
	F: 65 : 35	152.68	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Mixed *rasi*with mung beans generate the highest rehydration power, whereas mixed *rasi* withrice groats generate the lowest rehydration power. The higher the rehydration power,the faster the extrudate absorbing water so that the cooking process will be quicker because during the cooking process, the starch will undergo gelatinization that supported by the presence of water [10].

Rehydration power is affected by the ability of starch development, temperature and duration of drying. The drying process will produce porous structures that will allow water to seep into the material during rehydration [11].In drying process, moisture content is reduced and the product becomes more porous. A more porous product will be rehydrated faster. In producing the extrudate, temperature and duration of drying are made uniform, so that the factors that cause rehydration power of the product different is the ability of starch development.

The ability of starch development is influenced by the size of starch granules. The size of granule is influenced by gelatinization temperature, where the larger the size of granules,the lower the gelatinization temperature. Large granules tend to expand first rather than the small ones, so that gelatinization occurs sooner [11]. The more *rasi*is used, the size of starch granules in the dough on average be large. The difference in granule size causesthe rehydration power ofthe extrudates with higher ratio of *rasi* will be higher, because it will be increasingly porous when dried.

The presence of fat and protein in the material also affects rehydration power of the products. Protein and fat will form a layer on the surface of starch granules which can restrict the penetration of water into the starch so that starch gelatinization process being less perfect [12]. It may lead to the resulted foodstuffs structure becomes less porous so the ability to absorb water is reduced.Figure 2 and 5 show thatthe mixture of *rasi* with mung beans produces extrudate with the highest protein content but high rehydration power. Similarly, mixed *rasi* with corn flour has the highest fat content of extrudates but rehydration power is also high. This can be caused by the high content of starch and the large size of granules so that the ability of bonding and absorption remains high.

Hardness and Stickiness

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting hardness of extrudate. Results of the statistical test on the effect of treatment on the hardness of extrudate can be seen in Table 6.

Table 6. The Influence of Various Treatments on the Hardness

Treatments		Average Value of Hardness (gF)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	4711.31	b
	B: 70 : 30	5957.77	a
Rasi : Rice Groats	C: 55 : 45	2396.59	c
	D: 50 : 50	2182.42	c
Rasi : Mung bean Flour	E: 70 : 30	6328.84	a
	F: 65 : 35	6463.83	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Rice hardness testing refers to the maximum force on the probe pressure required to press rice by 50% until the grains are broken. The greater the used of force to push the product to break, the greater the hardness value, which means the product harder. Hardness values are expressed in grams of force (gF).

Mixed *rasi*with rice groats produce the most friable texture than other treatments while the mixture of *rasi* with mung beans produce a texture that is harder than other treatments. During storage rice is usually stacked to save space, so it requires a fairly high hardness so that the rice is not easily destroyed during storage. It needs proper packaging to pack extrudates, especially extrudates of a mixture of *rasi* and rice groats because its texture is more fragile than the other extrudates.

The composition of the raw materials used can affect the level of hardnessof extrudates. Products that are made of high amylose starch will be denser, harder, and less expands when extruded [11]. The high levels of amylose in extrudates from mixed *rasi* with corn flour or mung bean flour make the texture becomes harder than extrudates from a mixture of rasiwith rice groats.

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting stickiness of extrudate. Results of the statistical test on the effect of treatment on the stickiness of extrudate can be seen in Table 7.

Table 7. The Influence of Various Treatments on the Stickiness

Treatments		Average Value of Stickiness (gF)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	-5.57	b
	B: 70 : 30	-4.43	c
Rasi : Rice Groats	C: 55 : 45	-10.59	a
	D: 50 : 50	-10.85	a
Rasi : Mung bean Flour	E: 70 : 30	-5.76	b
	F: 65 : 35	-5.72	b

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Testing in boiled rice texture forstickiness refers to the force required to remove the sample from the surface of the probe after the samples are pressed by the probe of up to 50%. The more difficult the samples escape from the probe surface, the more sticky the samples, characterized by large negative value. Negative values indicate the opposite direction of the force between the probeand the samples. Stickiness values expressed in grams of force (gF).

Of the six treatment, the extrudates with mixed *rasi* and rice groats produce more sticky boiled rice than other treatments. It is influenced by a lower content of amylose content and belong to the low amylose.

Based on the analysis results, the more *rasi*is used, the lower the value of the stickiness so that the product is not sticky. Amylose levels correlate negatively to the stickiness of rice, or the higher the amylose content, the lower the stickiness of rice. Rice with low amylose content or high amylopectin content,give more sticky rice and hardened slowly because amylopectin will hold water longer [13]. The theory is consistent with the conducting study, whereby the greater the amylose content of extrudate, the smaller the stickiness of generated rice (less sticky).

Organoleptic

Organoleptic tests were performed for extrudate derived from a mixture of *rasi*withrice groats and rasi with mung beans,by using multiple comparison test to determine the quality of the product compared to commercial rice. While extrudates frommixed *rasi*with corn flour, the test was a hedonic test to determine the level of preference for the product characteristics as the protein is still below the value of commercial rice.

Color

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate did not give significant effect on the color of extrudate. Results of the statistical test on the effect of treatment on the color of extrudate can be seen in Table 8.

Table 8. The Influence of Various Treatments on the Color

Treatments		Average Value of Color	Result of Duncan Test
Rasi : Rice Groats	C: 55 : 45	4.99	a
	D: 50 : 50	4.90	a
Rasi : Mung bean Flour	E: 70 : 30	5.04	a
	F: 65 : 35	5.13	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Based on the chart above, between the treatment did not provide a statistically significant different results. The average value of the multiple comparison test to extrudate color was 4.90 to 5.13, which means the panelists gave a score that the samples tend to have a color somewhat worse than commercial rice. Colour of product that produced from a mixture of *rasi* with rice groats are greyish brown color while the mixture of*rasi* with mung bean flour is yellowish brown.

There is a trend that the more *rasi* was added, the boiled rice is likely to be somewhat worse than commercial rice. This assessmentis due to, the more*rasi* were added the color of rice will become greyish brown. The more rice groats are used, the rice color will becomegreyish white, it is due to milky white color of rice groats when cooked. The moremung bean flour were used, the darker the brown color.

Hedonic tests in extrudates froma mixture of *rasi*with corn flour generate significant different statistical results. The average of A treatment was 3.40 and for B treatment was 2.92. This shows that the color of rice with A treatment more favourable over rice with B treatment. The color of rice is influenced by the addition of corn flour where more corn flour is used then the resulting color of rice is yellow. Therefore rice with A treatment is preferred because the color tends to be so close to the white color of common commercial rice.

Brown color on rice is caused by'browning'. One of the cause of browning is Maillard reaction. Maillard reaction occurs between the aldehyde group of a reducing sugar with the amine group of amino acids, especially epsilon-amino- lysine and alpha-amino, N-terminal amino acids. Very high protein content inmung bean flour make resulting rice becomes more brown than the other treatments.

The color of food has a very important role [14]. Attractivenessto color is the first assessment to determine the acceptability of the food products. Therefore, rice from mixed*rasi* with corn flour is probably more accepted by people than rice produced from a mixture of *rasi* with rice groats or with mung beans.

Aroma

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting aroma of extrudate. Results of the statistical test on the effect of treatment on the aroma of extrudate can be seen in Table 9.

Table 9. The Influence of Various Treatments on the Aroma

Treatments		Average Value of Aroma	Result of Duncan Test
Rasi : Rice Groats	C: 55 : 45	5.21	a
	D: 50 : 50	5.26	a
Rasi : Mung bean Flour	E: 70 : 30	4.90	a
	F: 65 : 35	4.83	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Based on the chart above, between the treatment did not provide a statistically significant different results.The average value of the multiple comparison test to extrudate aroma was 4.8 to 5.3, which means that the panelists gave a score that the samples tend to havean aroma somewhat worse than commercial rice.

According to the panelists preferred aroma is distinctive rice aroma, while these products do not have the distinctive aroma of rice because it uses *rasi*and corn flour orrice groats andmung bean flour that have different smell with those of rice in general. The role of aroma in food is very important because the aroma also determine consumer acceptability. Aroma is not only determined by one component, but by certain components that cause a characteristic odor [7].

According to the panelists commercial rice has an aroma better than products resulted from a mixture of *rasi* with rice groats because of its moldy and pungent aroma. Moldy smell probably derived from rice groats due to carbonyl compounds that are rancid, ie compounds resultedfrom fat oxidation with oxygen from the air. Rice produced from *rasi* mixed with mung beans was also less preferred because it is very pungent. Rasi and mung beans are materials that have a pungent aroma, so that when combined will produce very pungent aroma.

Extrudates of mixed *rasi*with corn flourwas performedfor hedonic test and produces an average value of not significantly different,ranging from 2.37 to 2.83 for A treatment and B treatment. The figure shows that the aroma of rice produced is less preferred by the panelists. The resulting *rasi* aroma was more pungent than the aroma produced by corn flour so the more corn flour is usedthe strong aroma of *rasi*can be covered.

Taste

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate gave significant effect on the resulting taste of extrudate. Results of the statistical test on the effect of treatment on the taste of extrudate can be seen in Table 10.

Table 10. The Influence of Various Treatments on the Taste

Treatments		Average Value of Taste	Result of Duncan Test
Rasi : Rice Groats	C: 55 : 45	4.54	a
	D: 50 : 50	4.67	a
Rasi : Mung bean Flour	E: 70 : 30	4.82	a
	F: 65 : 35	4.83	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Table 10 shows that the average value of multiple comparison test to the taste of resulting extrudate was 4.5 to 4.8, which means the panelists scoresaresimilar to those of commercial rice. The more *rasi* was added, the taste of rice is likely to be somewhat worse than commercial rice.

The more rice groats were added then the rice will have a strong sense of groats. Rice groats tastes like rice, where this flavor is quite liked by the panelists. The tastethat tend to be the same as the commercial rice is expected in this product, because it is expected to increase public acceptance of the product.

Taste produced from a mixture of *rasi* with mung bean flour are considered to be worse than the commercial rice compare to a mixture of *rasi* with rice groats.Mung beans have a distinctive flavor and powerful that it dominates the rice flavor rice.

Results of hedonic tests in extrudates with *rasi*and corn flour produces an average value of not significant different, ranging from the 3.77 to 3.57 for Aand B treatment. This value indicates that the resulting rice tasteis preferred by the panelists. *Rasi* has a slightly distinctive flavor while corn flour is lacked of flavor. Panelists prefer rice with a bigger ratio of *rasi*perhaps *rasi*gives a little taste to the rice produced. Boiled rice from a mixture of *rasi* with corn flour tends to give flavorless taste because *rasi* and the corn flour as the raw materials do not have very strong taste.

Overall Appearance

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate didnot give significant effect on the overall appearance of extrudate. Results of the statistical test on the effect of treatment on the overall appearance of extrudate can be seen in Table 11.

Table 11. The Influence of Various Treatments on the Color

Treatments		Average Value of Overal Appearance	Result of Duncan Test
Rasi : Rice Groats	C: 55 : 45	4.54	a
	D: 50 : 50	4.58	a
Rasi : Mung bean Flour	E: 70 : 30	4.65	a
	F: 65 : 35	4.69	a

Note : The average value of treatment indicated by different letters differ significantly, expressed at 5% level test according to Duncan Test.

Based on the chart above, the average value of multiple comparison test against the organoleptic properties of extrudates in overall ranged from 4.5 to 4.7, which means that the panelists gave a score that the overall appearance tends to be somewhat worse than commercial rice. Overall appearance is mainly valued by the color and shape of rice as well as boiled rice. The result of extrudate is expected to have a better overall appearance than commercial rice because the first assessment of a product usually is the overall appearance.

In extrudates with a mixture of*rasi* and corn flour,the hedonic tests produces an average value of not significantly different, ranging from 3.03 to 3.05 for A and B treatment respectivelly. This value indicates that the overall boiled rice produced is favored by the panelists. It is caused that the formation of extrudate was conditioned equally, so in terms of form not so much different. The resulting yellow color of rice of mixed *rasi* with corn flour is not unusual because there are already yellow rice and the public will accept it. The aroma of *rasi* which is quite pungent is less preferred by the panelists, the texture is not too sticky to make easy to consume by panelists, and the tasteless of mixed *rasi* with corn flour make it easily to be combined with other side dishes.

Yield (Rendement)

Based on the results of statistical tests, treatment in producing rice grain-shaped extrudate did not give significant effect on the yield of extrudate. Results of the statistical test on the effect of treatment on the yield of extrudate can be seen in Table 12.

Table 12. The Influence of Various Treatments on the Rendement

Treatments		Average Value of Stickiness (gF)	Result of Duncan Test
Rasi : Corn Flour	A: 85 : 15	50.98	a
	B: 70 : 30	51.48	a
Rasi : Rice Groats	C: 55 : 45	46.30	a
	D: 50 : 50	49.30	a
Rasi : Mung bean Flour	E: 70 : 30	53.73	a
	F: 65 : 35	51.13	a

Note : The average value of treatment indicated by different letters differ significantly,expressed at 5% level test according to Duncan Test.

Table 12 shows that the average yield of 1 kg of dough is ± 50%. It indicates that most of the water contained in thedough is free water. Processes that influence the resulting yield is drying because drying causes a reducing weight [15]. Yield values are also related with the remaining dough in the extruder because it can not get out again through the die.

Moisture test results (Table 3) also shows that all treatments gave no significant difference so that after the drying process it will produces not much different yield of extrudates. Factors related to this yield was the use of an extruder, dryers, time, and drying temperature that was setin the same condition for each treatment and the materials used are also derived from the same source.

Conclusion

Based on this research, the three mixtures of raw materials give significantly different influence on the levels of amylose, protein content, fat content, rehydration power, hardness and stickiness, and they tend not to give a significantly different effect on moisture content and yield, as well as panelists evaluationon color, aroma, taste and the overall appearance.

The extrudate from the mixture of *rasi* and mung bean flour produces very good physical, chemical and organoleptic characteristics and more preferable compare to other mixtures, having 152.68%rehydration power, 6463.84 gF hardness, -5.76 gF stickiness, 6.47% water content, 20.24% amylose content, 9.13% protein, 0.23% fat content and organoleptic properties (color, aroma, taste, overall appearance) that are better than commercial rice and more preferable by panelists.

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