

Effects of Food Additives Treatment on the Texture of Artificial Rice prepared from Dried Cassava and Corn Flours Mixture

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Abstract. Cassava is one of the main potential raw materials in food industries that consists of carbohydrates, proteins, minerals, fibers, calcium and phosphates. Tiwul Rice is an artificial rice made from 70% dried cassava flours dan 30% corn flours and it is produced using extrusion process with specified temperature and pressure. The artificial rice hardness and chewiness textures can be improved by adding STPP, guar gum and GMS. Another texture such as gumminess can be enhanced using GMS. Tiwul rice that is produced with 0.5% GMS addition obtains several characteristics that are nearly similar with native rice, such as hardness, cohesiveness, adhesiveness, springiness, gumminess and chewiness textures.

1. Introduction

Rice becomes the primary food sources in Asia especially South Asia, South East Asia and East Asia. The annual consumption level of rice as primary food in Indonesia reaches up to 139 kg/capita. Moreover, Indonesia has to import around 2,75 million tons of rice to meet the domestic demands, in which equals to USD 1.513,6 million and it is predicted that Indonesia will have rice shortage 3.009 tons in 2019-2021. These indicate the high level of community dependence on a single source of carbohydrates only, whereas the potency of local carbohydrates sources such as group of tubers and grains in Indonesia are quite diverse [1] and the shortage can inflict some problems in national food resilience, economy and security.

In order to overcome the problems, the Indonesian government conducts food diversification programs to reduce the domestic rice consumption level. The programs are utilizing local food sources except rice such as corn, sorghum, cassava, sweet potato, sago and others. The development of non-rice food (analog/artificial rice) is needed to support the programs and Indonesia has huge potential corn productions as one of non-rice food sources with production rate 5.34% per year and achieving 17.64 million tons from 5.73 million tons in 1990-2011 [2][3][4].

The obstacles of those food sources are less familiar than rice, the consumption level declines every year, rice is easy to find and cook, and the strong tradition of Indonesia people to eat rice three times a day, make the people is difficult to eat other food sources as primary food. Therefore, the non-rice food sources need to be processed to such an extent, so the product has nearly similar or similar characteristics with rice, such as the physical grains, cooking and textures.

Artificial rice is the imitation of native rice that is produced from tuber roots and cereals that have shapes and nutrient compositions similar with rice [5]. Artificial rice is expected to be one of the diversification food products, in which it does not change people's eating habits. Raw materials to make artificial rice also diverse such as cassava, purple yam, corn, and a mixture of various flours [6] with or without functionality and nutrient addition [7]. Similar studies in artificial rice production had been carried out from cassava, green and hanjeli [3]; modified cassava and corn [7]; purple sweet potato [8]; cassava corn and taro [9]; and cassava, avocado seeds, and tofu waste [10].

There are two methods for producing artificial rice, which are granulation and extrusion. Artificial rice can be produced using hot extrusion [11] and it is widely developed because it is suitable for large capacity and simpler production than granulation. The main process and raw material handling are in one equipment become the main advantages of extrusion simplification.

The objective of this research is to know the effects of food additives such as Sodium Tri Poly Phosphate (STPP), Guar Gum and Glycerol Monostearat (GMS) toward artificial rice (tiwul rice) textures with extrusion method.

2. Materials and methods

2.1. Materials

Dried cassava flours were obtained from food grade production of raw dried cassava and corn flours were purchased from PT. Kediri Matahari Corn Mills. Food additives such as STPP, Guar Gum, and GMS were purchased from PT. Asian Bahan Farmasi. The main equipment for this research was Twin Screw Extruder (Shandong, Cina) type LT 70.



Figure 1. Twin Screw Extruder (Shandong, Cina) Type LT 70

2.2 Experimental Design

The experimental design that was used in this research is shown in Table 1.

Table 1. Tiwul Rice with *Sodium Tri Poli Phosphat* (STPP), *Guar Gum*, dan *Gliserol Monostearat* (GMS) Formulations

Formulation Codes	Dried Cassava Flour (%)	Corn Flour (%)	STPP (%)	Guar Gum (%)	GMS (%)
A	70	30			
B	70	30	0,3		
C	70	30	0,5		
D	70	30		0,5	
E	70	30		2	
F	70	30			0,25
G	70	30			0,5

2.3 Research Steps

Research steps for this research can be elaborated in Figure 2 below.

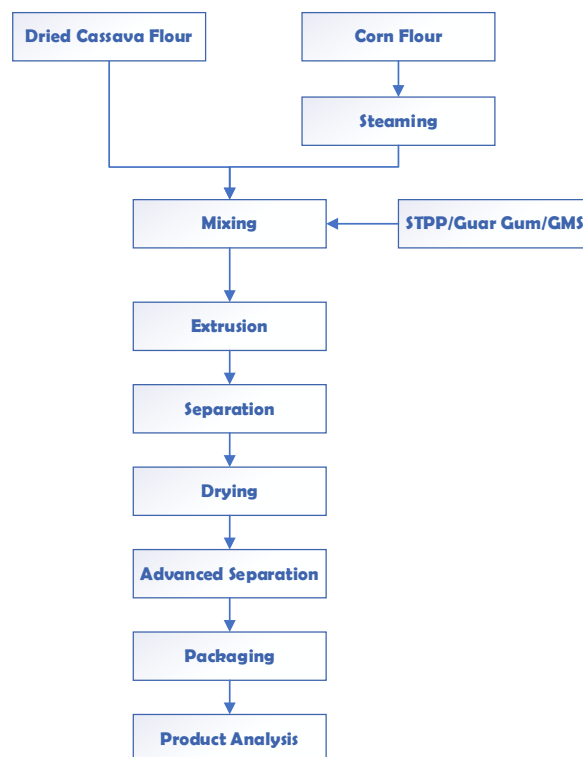


Figure 2. Flowchart Diagram of Tiwul Rice Production from Dried Cassava and Corn Flours

3. Result and discussion

3.1 Tiwul Rice Production

Extrusion process in this artificial rice production was giving physical treatment as heat and pressure combination to the raw material mixtures. The process steps in this production were raw material mixing, extrusion, drying and advanced separation.

The rice was made from a mixture of dried cassava and corn flours with ratio 70%: 30%. Dried cassava was cleaned to remove the impurities, prior to immerse in immersion tank for 12 hours. Further, it was rasped and pressed for reducing the moisture content until 30-35% to make dried cassava flours. The corn flours with size 40 mesh were mixed with water, until its moisture content reached 30%, then followed by steaming process at 70°C for 20 minutes.

The dried cassava and steamed corn flours were mixed into a mixer and added with water until its moisture content is 30 – 35%. After that, the mixture was placed in a Hopper with a feeding screw to the inlet barrel of the twin screw extruder. The process conditions inside the extruder were determined: feeding screw motor speed was 5-6 Hz, Screw extruder motor speed was 7.5-8.5 Hz and temperature at the edge of extruder (area 3) was around 45-50°C.

The wet tiwul rice came out from extruder's dies and it would be cut with knife shelf that had cutting speed 22-23 Hz. Further, the rice was dried using dryer until its moisture content at maximum 12%. The moisture content was kept in that level to prolong the expiring date of the rice. Then, the advanced separation was held to gain a clean and smooth texture of the rice.

3.2 Texture Profile Analysis (TPA) of the Artificial Rice

Tiwul rice made both with or without STPP, Guar Gum and GMS, were analyzed its texture characteristics using TPA such as hardness, adhesiveness, cohesiveness, gumminess, chewiness, and springiness.

Hardness is the maximum peak of the initial pressure or bite in kg, g or N. Table 2 below showed that adding 0.3% STPP could improve tiwul rice hardness, but 0.5% STPP gave the opposite result. However, the value was not significantly different at $\alpha = 5\%$. The lower hardness could be caused by STPP characteristic as bipolar substance, in which water easily penetrates inside the granular and bonds internally. During extrusion, chemical reaction that happened on starch surfaces [12], became one of the factors that caused level penetration of the water. Moreover, the increasing amounts of phosphate in tiwul rice production could cause the declining of rice hardness, in which phosphate enhances the material porosity so the water will easier penetrate into it [13]. Guar Gum also could improve tiwul rice hardness but the value still not similar with native rice's hardness. On the other hand, the addition of GMS could improve its hardness until it reached native rice hardness at $\alpha = 5\%$. Regarding to [14], adding GMS could lower the hardness of starch products, in which GMS formed some structural complexes with amylose.

Springiness or elasticity is recovery time between the end of first bite and the initial of second bite. There is no unit for elasticity because it determines the difference area of the time. Table 2 showed that additive agent in food did not significantly change the springiness

value at $\alpha = 5\%$. Further, the springiness of tiwul rice was similar with native rice and it was caused by the full gelatinization during the rice production. The gelatinization was occurred by extruder temperature, shear stress and leaching of amylose during the process production. Afterward, the drying process after extrusion could lead to retrogradation of the amylose.

Cohesiveness is measured as a level when material can be broken mechanically and there is no unit value for this parameter. The secondary parameters of cohesiveness are brittleness, chewiness and gumminess. There was no increase in tiwul rice cohesiveness when STPP, Guar Gum or GMS was added in the rice formula at $\alpha = 5\%$ as it is shown in Table 2. Further, the tiwul rice cohesiveness was similar with cohesiveness of native rice. Adding food additives would enhance the ability of starch to bond with water, so the end product would be more cohesive and elastic. The rice cohesiveness can be caused by the increasing amount of water and starch gelatinization during rice cooking [15].

Gumminess is the energy consumption to reduce food so it is ready to be swallowed [16]. The gumminess value can be calculated as multiplication of hardness and cohesiveness and it has no value unit. Moreover, semi-solid food characteristic had low hardness value, but high cohesiveness value. Table 2 described the addition of STPP and Guar Gum gave no improvement on gumminess texture of tiwul rice at $\alpha = 5\%$. However, GMS improved the tiwul rice gumminess until it was the same with native rice gumminess. This happened because the effect of hardness of the rice, in which the rice sample that was added with GMS shows higher value of hardness rather than the sample that was added with STPP and Guar Gum.

Chewiness is defined as the consumption energy that is needed to chew the food until it is ready to be swallowed. According to [17], the chewiness is affected by product hardness, in which the higher of hardness value generates higher chewiness value. Chewiness value was calculated from multiplication of gumminess value and springiness. Table 2 exhibited the effect of STPP, Guar Gum or GMS in tiwul rice chewiness, so the level of its chewiness complied with native rice chewiness. Chewiness is a texture characteristic that hardly precise to be measured, because it involves compressing, shearing, piercing, grinding, tearing, and cutting along with lubrication from human saliva at certain body temperature.

Table 2. Texture Profile Analysis of Tiwul Rice

Parameters	Specification and Level of Food Additives							Native Rice
	Blank	STPP (%)		Guar Gum (%)		GMS (%)		
		0,30	0,50	0,50	2,00	0,25	0,50	
Hardness	37,9300 ^a	46,3850 ^{ab}	33,5795 ^a	46,3255 ^{ab}	42,9350 ^a	59,1645 ^{ab}	66,6360 ^{ab}	83,0825 ^b
Adhesiveness	50,7418 ^a	114,9850 ^{ab}	116,9500 ^{ab}	82,0305 ^{ab}	127,9450 ^b	140,2750 ^b	123,560 ^b	95,550 ^{ab}
Cohesiveness	0,1129 ^a	0,1191 ^a	0,0988 ^a	0,1365 ^a	0,1221 ^a	0,1236 ^a	0,1545 ^a	0,1632 ^a

<i>Gumminess</i>	7,1828 ^a	7,5819 ^a	5,3988 ^a	7,8966 ^a	5,8130 ^a	9,1250 ^{ab}	14,8450 ^{ab}	20,8540 ^b
<i>Chewiness</i>	5,5211 ^{ab}	5,8822 ^{ab}	4,3540 ^a	5,9743 ^{ab}	4,5954 ^a	7,8726 ^{ab}	11,5464 ^{ab}	14,9998 ^b
<i>Springiness</i>	0,7701 ^{ab}	0,7839 ^{abc}	0,8364 ^{bc}	0,7561 ^a	0,7940 ^{abc}	0,8628 ^c	0,7758 ^{abc}	0,7108 ^a

3.3 Tiwul Rice Cooking

Tiwul Rice cooking method was conventional as native rice cooking method, including washing, draining and steaming the rice grains using steamer for 45 minutes. There was no need to soak the rice after washing and typical steamer that was used for cooking rice was rice cooker. In details, methods for using rice cooker were washing, draining and putting the rice grains in the cooker, adding hot water with the mass ratio towards rice grains was 1,5 and pressing “Cook” button on rice cooker. The rice had already cooked when the button was automatically off, stirred the cooked rice briefly and waited for 10 minutes before the rice is ready to be served.

4. Conclusion

The additions of STPP, Guar Gum and GMS about 0.5% could improve hardness and chewiness of tiwul rice, whereas its elasticity and springiness were constant. The gumminess of tiwul rice was increased only by adding GMS but not for STPP and Guar Gum. Therefore, it could be concluded that the addition of GMS by 0.5% for making tiwul rice from a mixture of dried cassava and corn flours, could improve the hardness, cohesiveness, adhesiveness, springiness, gumminess, and chewiness of the rice, in which its values were similar with the native rice values.

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