Prospect of specialty maize as functional food to support food diversification in Indonesia

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Abstract. Functional maize contains various advantages over normal maize in term of usage not only since milk stage but also harvest stage. Another advantage of functional maize is the diversity of colors such as read, yellow, purple, and black with different physicochemical character. Physicochemical character of maize is the main base to choose variety that appropriate with the preferred product, by count the functional food element. Maize color is the clue of high compound content that has health benefits. For example, anthocyanin contained in purple and black maize, carotene compound in yellow and red maize, Fe mineral in red maize. Those compounds are antioxidant, mineral which needed for human health. Maize-based food products contain dietary fiber with antioxidant content hat very needed by health specially to anticipate degenerative diseases. Another challenges of specialty maize are raw materials availability and food diversification support from government. The abundant maize germplasm in Indonesia is adequa
t to develop, with touches of variety development and cultivation technology that can increase production will transform the special maize become functional food material that has high value. In Indonesia, MOA has released various functional maize such as QPM maize, Provit A maize, waxy maize and purple maize. This paper discussed the development of functional maize research in Indonesia and its contribution for supporting food diversity in Indonesia.

1. Introduction
The advantage of maize as a food functional compared to other cereals is that during milk stage, maize can be processed in various types of food, from traditional to modern processing so that it can anticipate food and nutrition insufficiency [1]. The variety of colors of maize kernels shows that they are rich in functional food components, including maize yellow, red maize, black maize including purple maize. In this paper, purple maize will be discussed, because it is still rare so that people are curious and interested in its processed colors. Purple maize contains adequate nutrients particularly anthocyanin compounds [2], but have not been popular and grown in Indonesia. Local variety purple maize (from Gorontalo province) produce deep purple color but low productivity [3]. Anticipating this, Indonesian Cereals Research Institute (ICERI) has been developing superior varieties of purple maize by maintaining a purple pigment grains, along with higher yield. The specific advantage of this variety is the anthocyanin components.

Anthocyanin antioxidant activity is influenced by the system used as a substrate and conditions used to catalyze the oxidation reaction [4]. The presence of these compounds in the growth phase of maize plants depends on the variety and physiological cooking [1]. Information about the percentage of purple maize anthocyanin components is still difficult to obtain. In connection, it is necessary to conduct research starting from the effect of harvest age on nutritional components, characterization of
physicochemical and functional properties, to diversification of superior products [5]. Based on the results of the study, users can refer to the appropriate harvest phase according to the desired product both as functional and industrial food ingredients. The results of this study, can also be a data source for the release of superior purple maize varieties. In the future, it is expected that superior varieties of purple maize can be used in the community to develop healthy food products.

2. Nutrition Content, Anthocyanin and Purple Maize Physicochemical Properties

Study on nutrition value of purple maize was conducted in 2015-2017. Proximate composition and young harvested purple maize anthocyanins is shown in Table 1.

| Harvest age / Strain varieties | Water (%) | Ash (%) | Protein (%) | Fat (%) | Carbohydrate (%) | Anthocyanin (µg/g) |
|-------------------------------|-----------|---------|-------------|---------|------------------|-------------------|
| PMU (S1) Synth.F.C1           |           |         |             |         |                  |                   |
| 70 days                       | 59.52     | 0.59    | 3.48        | 0.39    | 36.02            | 1.55              |
| 75 days                       | 50.23     | 0.64    | 4.08        | 0.76    | 44.29            | 5.51              |
| 80 days                       | 47.09     | 0.76    | 5.42        | 1.08    | 45.65            | 5.94              |
| Maluku local purple           |           |         |             |         |                  |                   |
| 70 days                       | 62.05     | 0.47    | 2.79        | 0.32    | 34.37            | 1.02              |
| 75 days                       | 59.12     | 0.52    | 3.13        | 0.59    | 36.64            | 1.25              |
| 80 days                       | 52.94     | 0.69    | 3.75        | 0.77    | 41.85            | 1.46              |

The results of the analysis showed that water, ash, protein, fat and carbohydrate content were significantly different at different harvesting ages. Maize harvested at mild stage show water content decreases following the increasing age. In contrast to the levels of ash, protein and fat, the age of the plant will increase, increasing following the increase in the nutrient component. Likewise, carbohydrate levels will increase, along with the decrease in water content of maize kernels. In terms of nutritional content of young harvest maize is still low, but at least earlier can be processed various ready-to-consume products so that they are superior in anticipating food insecurity [6]. Anthocyanin components in milk stage harvested maize kernels are presented in Table 2. Furthermore, a number of candidates for purple maize varieties from various germplasm origins were evaluated including proximate components (Table 2).

| Variety /lines | Water (%) | Ash (%) | Protein (%) | Fat (%) | Carbohydrate (%) | Crude fiber (%) |
|---------------|-----------|---------|-------------|---------|------------------|----------------|
| PMU (S1) Synth.F.C1 | 10.86     | 1.59    | 9.28        | 3.98    | 74.56            | 2.73            |
| PTU (S1) F.CO  | 11.05     | 1.49    | 8.81        | 4.05    | 74.60            | 2.99            |
| PVU.FS. CO     | 10.11     | 1.69    | 8.28        | 4.34    | 75.58            | 3.02            |
| PPU. (S1) .C1  | 11.12     | 1.57    | 7.78        | 3.79    | 75.74            | 2.28            |

| Variety of varieties | Anthocyanin (µg/g) | Amylose (%) | Food fiber (%) |
|----------------------|--------------------|-------------|----------------|
| PMU (S1) Synth.F.C1  | 51.36              | 5.77        | 9.16           |
| PTU (S1) F.CO       | 37.15              | 8.02        | 6.01           |
| PVU (S1) CO         | 20.86              | 7.02        | 8.25           |
| PPU. (S1) .C1       | 12.10              | 6.04        | 11.27          |
The main type of anthocyanin in purple maize is cyaniding-3-glucoside, pelargonidin-3-glucoside, peonidin-3-glucoside [7]. Identification and characterization of anthocyanins by high performance liquid chromatography - electro-spray ionization and mass spectrometry [8, 9]. Anthocyanin analysis in the sample above was calculated as TAC (μg/g cyanidine). Anthocyanin content of PMU (S1) strain. Synth.F.C1 is higher than other strains. Amylose and amylopectin ingredients have a role in determining the properties of foods processed from starch, such as maize flour [10, 11]. From the results of amylographic analysis of purple maize flour, there are several measured parameters, including gelatinization time, peak viscosity, peak viscosity, for the level of softness and crispness of the processed product can also be seen from the back viscosity (set back viscosity). The viscosity of purple maize flour is very low and PMU (S1) Synth.F.C1 is higher than the others. The decrease in viscosity during heating shows the stability of the paste during heating, where the lower the breakdown, the paste that is formed will be more stable against heat.

Table 4. Amylographic properties of purple maize flour.

| Amilography | PMU (S1) Synth.F.C1 | PPU. (S1).C1 | PTU (S1) D.CO | PVU (S1) CO |
|-------------|---------------------|--------------|--------------|-------------|
| Gel Time (minutes) | -                  | -            | -            | -           |
| Gel temp (°C)    | 87.0                | 85.5         | 82.5         | 87.0        |
| Peak Time (minutes) | -                   | -            | -            | -           |
| Peak Temp (°C)   | -                   | -            | -            | -           |
| Peak Viscosity (BU)| -                   | -            | -            | -           |
| Viscositas 93°C (BU) | 50               | 130          | 150          | 80          |
| Viscosity 93°C/120 °C (BU) | 80            | 170          | 190          | 110         |
| Viscosity 50°C (BU)  | 300                | 320          | 380          | 210         |
| Set Back Visc. (BU) | 220                | 150          | 190          | 100         |

Among the effect on the amylographic properties of flour is the composition of amylopectin and amylose. The magnitude of the breakdown viscosity indicates that the flour granules that have swollen the whole is fragile and cannot stand the heating process [14]. The lower the breakdown viscosity is only (220 BU), the starch is more stable in conditions heat and given a mechanical force (shear). Amylose greatly affects the hardness of the product because of its ability to form strong hydrogen bonds between amylose or between amylose and amylopectin after bakery products are roasted and cooled. In this case, low purple maize flour amylose is included in the waxy category. Maize, especially waxy type, is suitable for use in various food preparations such as bakery products to improve the typical texture characteristics of the product [10]. This is related to the physical and rheological characteristics (amylographic properties) of maize starch. Furthermore, it appears that dietary fiber content of maize flour is relatively high, 9.16% compared to 2.13% wheat only.

High food fiber can also increase violence [11] and reduce elasticity [12]. Excess purple maize flour and wheat, and vice versa can be mutually improves physicochemical to produce products such as brownies and the like. Water absorption capacity is related to the composition of the granules and the physical properties of the starch after being added with some water. Starch granules can be wet and spontaneously dispersed in water. The absorbed water is caused by absorption by the granulesphysically and intermolecularly bound to the amorphous part [12]. Flour oil absorption capacity is influenced by the presence of protein on the surface of starch granules, which form complexes with starch, then provide a place for the oil to bind. In connection with this, it can be seen that flour KPM (O, 870) is higher than purple maize flour (0.796).

3. Various Purple Maize Processed Products
Young harvested maize can be processed into juice (purple maize juice) and purple maize ice cream. Another product is dodol local purple maize flour, the treatment most received/preferred by
panelists is (sugar = 155g, 30 minutes cooking). The product still maintains anthocyanin content due to relatively short cooking. Physiologically matured purple maize can be processed into semi-finished ingredients in the form of flour. Purple maize flour can substitute flour up to 80% for processed brownies, although the panelists scored the highest on 40% and 70% substitution by cooking steamed methods. Anthocyanin levels can still be maintained compared to roasting methods. Maize cake substitution products for flour (90: 110) are the most suitable from the basic ingredients of purple maize flour and still contain anthocyanins [1,15]

4. Special Maize Development Strategy in Indonesia
The diversification of special maize-based functional food is still limited. However, in the future it is expected to be an important component of functional food so as to enhance the image of special maize as a superior food material. The development of polysaccharide-based functional food from maize for anti-cholesterol has good prospects. Special maize superior varieties including high productivity and potential purple maize as functional food can be explored in ready-to-consume products [3, 16].

The need for "Maize center specifically" activities began training in special maize cultivation can be carried out in the frame work of technology transfer (technology transfer) to farmers and agricultural extension workers on the cultivation of maize specifically with the application of organic fertilizers, biological fertilizers and biological pesticides as well as processing maize crop products specifically to be functional food ingredients. Special maize development still faces various problems, especially related to market creation and price guarantee as well as institutional aspects for the sustainability of maize development. What ever the farmer can do for any commodity, the important thing is that the crop gets a market guarantee that receives it at a more favorable price.

5. Conclusion
• Purple maize can be processed into various products where anthocyanin content can still be maintained, purple maize can be processed since milk stage until harvest stage to fulfill maize based food demand.
• The prospect of developing maize specifically in Indonesia began to have a market, because people began to change their lifestyle to consume healthy food "functional food products".

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