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Effect of corn varieties on the characteristics of soycorn milk

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Abstract

Three corn varieties (normal yellow, normal white and sweet yellow) were used to produce soycorn milk. After steaming, the corn was blended with boiled soybean at a ratio of corn and soybean of 30:70, followed by extraction with water at a ratio of blend and water of 1:5; filtered and the filtrate was mixed with other ingredients and packed in plastic bottles. The soycorn milks were analyzed for their physical characteristics (viscosity and colloidal stability), chemical characteristics (protein content, *in vitro* protein digestibility/IVPD and aflatoxin content) and sensory characteristics (colour, appearance and taste preferences). The corn types did not significantly affect the viscosity and colloidal stability. The normal yellow corn produced soycorn milk with higher protein content (1.38%), IVPD (81.58%) than those of normal white corn and sweet yellow corn with the preference scores of 4.00; 4.10 and 3.92 for colour, appearance and taste, respectively. Aflatoxin B_1, B_2, G_1 and G_2 were not detected in all of soycorn milk types.

Introduction

Soycorn milk is a nutritious beverage made from aqueous extract of soybean and corn blend. Combination of soybean and corn produce soycorn milk with higher preference scores than those of soy milk. Kolapo dan Oladimedji (2008) reported that soycorn milk, produced with non sweet yellow corn at ratio 75:25, has higher overall acceptability. In addition, Srianta *et al*. (2010) also reported that soycorn milk, produced with sweet yellow corn at ratio 70:30, has higher preference scores than those of soy milk. These studies showed that different types of corn could produce soycorn milk with good acceptability. In 2000, Omueti and co-workers reported that *in vitro* protein digestibility (IVPD) of soycorn milk was 88%, close to the IVPD of casein (90%).

The different corn varieties may produce soycorn milk with different physical, chemical and sensory characteristics. Physically, corn kernel type exists in various forms such as dent, flint, pop, pod, sweet, etc. Based on the color, corn is divided into 3 classes: white corn, yellow corn and mixed corn. Chemically, corn contains carbohydrate, protein, fat, vitamin and mineral. Corn carbohydrate consists of starch, sugar, pentosan, fiber and dextrin. Sugar content of corn is in a range of 1-3%, (consisting of glucose, fructose, and sucrose) and protein content of 8-11% (consisting of albumin, globulin, prolamin, and glutelin) (Suarni and Widowati, 2007). Yellow corn is rich in carotenoids. "Milky" stage corn on the cob is the most suitable as a raw material for soycorn milk production. It produces soycorn milk of good quality. From the perspective of food safety concern, corn is a commodity with high risk of *Aspergillus flavus* and *Aspergillus parasiticus* contamination, which could produce aflatoxin. Aflatoxins were detected in 8 of 27 samples of sweet corn at a level of below 4 ng/g and 1 sample contained of 5–10 ng/g (Candlish *et al*., 2000). Srianta *et al*. (2010) also reported that soycorn milk produced with sweet corn contain aflatoxin B1 of 0.24 ng/mL. The aim of this research was to study the effect of corn varieties on the characteristics of soycorn milk. Normal (non-sweet) yellow, normal white and sweet yellow corn varieties were used in this research.

Materials and Methods

Materials

Soybean (variety Wilis) was purchased from PT. Sang Hyang Seri, Pasuruan. "Milky" normal yellow and sweet yellow (variety Jambore) corns on the cob were purchased from local wholeseller in Surabaya and the "milky" normal white corn on the cob was purchased from local wholeseller in Lasem, East Java. Sugar and xanthan gum were purchased from

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local distributor. All chemicals were purchased from local chemical distributor, in Surabaya.

Processing of soycorn milk

One kilogram of sorted and cleaned soybean was soaked in water for 8 hours, removed the seed coat, washed, and then boiled for 30 min. After that, the grains were threshed out. Boiled soybean cotyledone and steamed corn were mixed at ratio of 70:30, then added with water at ratio of 1:5 (w/v). Extraction were done by grinding and boiling for 20 min in a soy milk maker, and then filtered. To the filtrate, sugar (10%) and xanthan gum (0.02%) were added. The soycorn milk was packed in polyethylene bottle of 330 mL volume. The soycorn milk were then analyzed for the physical characteristics (viscosity and colloidal stability), chemical characteristics (protein content, *in vitro* protein digestibility and aflatoxin content) and sensory characteristics (colour, appearance and taste preferences).

Viscosity and colloidal stability

The viscosity was measured using viscometer (Brookfield model DV-E). 250 mL of soycorn milk in a beaker glass was measured for viscosity using spindle 1 with minimum accuracy of 95%. The colloidal stability of soycorn milk was measured according to Lini (2010). 10 mL of soycorn milk samples were placed in graduated tubes held in racks in the refrigerator undisturbed at 4°C for 2 days. Changes in colloidal stability were indicated by separation into two layers. Level of visible line of demarcation between the settled and remaining portion of the milk solution was measured daily during 2 days of storage.

Protein content analysis

Protein content of soycorn milk was analyzed according to AOAC method (1990). A 5 ml of soycorn milk was digested by 25 ml of concentrated H_2SO_4 and Kjeldahl tablet (1.5% $CuSO_4$, 2% Selenium and 96.5% Na_2SO_4), then neutralised by 100 ml of NaOH 10 N and 100 ml of distilled water. The neutralised solution was distilled with 100 ml of HCl 0.1 N as receiving solution. Remaining HCl was measured by titration with standardised NaOH 0.1 N. Protein content was calculated by converting total nitrogen to protein using factor of 5.75.

In vitro *protein digestibility*

In vitro protein digestibility analysis was carried out according to Tanaka *et al.* (1978) and Briones *et al.* (1997). Sample was mixed with 9 mL of Buffer Walpole (pH 2,0) solution. The sample solution was then added with 1 mL of pepsin 2% solution. Sample solution was thoroughly stirred for 6 hours at 37°C, followed by centrifugation at 2000 rpm for 20 min. 6 mL of the supernatant was mixed with 5 mL of trichloro acetic acid 20%, and then incubated at 25°C for 15 hours. The solution was filtered with Whatman 41, and then the filtrate was analyzed for the total Nitrogen (mikro Kjeldahl).

Aflatoxin Analysis

Aflatoxin analysis was done by High Performance Liquid Chromatography (HPLC) according to Setyabudi *et al.* (2007). Soycorn milk was extracted and degreased by mixing 50 ml of sample with 50 ml of methanol and 1 g of NaCl, then filtered. Hexane (25 mL) was added to the filtrate and the methanol phase was collected. A 4 ml of the methanol phase was diluted with 16 ml of Buffer Phosphate Saline and loaded into Immunoaffinity Column (IAC), then washed by passing 10 ml of distilled water and completed by flushing air into IAC to remove remaining water. After that, elution through IAC with 1 ml of methanol (first, incubated for 5 min) following with 1 ml of methanol at flowrate of one drop per second. After that, 2 ml of the eluate was mixed with 50 µl of trifluoroacetic acid and 200 µl of n-hexane for derivatisation, then evaporated with stream of nitrogen gas, then reconstituted with 200 µl of mobile phase. A 20 µl of aliquot was injected into HPLC column with under the following conditions: HPLC column Octadesyl reverse-phase column (250 mm length × 4.6 mm i.d, 5 um), mobile phase acetonitrile/ methanol/water:11/26/63) with flowrate of 0.75 ml/min and fluorometer detector (λext 365 nm, λem 435 nm). Aflatoxin B_1, B_2, G_1 and G_2 were used as standard.

Sensory evaluation

The sensory evaluation of the soycorn milk were done by 90 panelists who are familiar with the soymilk. Hedonic method was used with scale of 1 represent dislike extremely to 5 represent like extremely. The panelists were requested to evaluate the colour, appearance and taste of the soycorn milk. The test was conducted in sensory evaluation room.

Statistical analysis

Data analysis was done by analysis of variance (ANOVA) with $\alpha = 5\%$ and followed by the Least Significant Difference (LSD) with $\alpha = 5\%$.

Results and Discussion

Physical characteristics

Table 1 showed the physical characteristics of soycorn milk representing the three different corn

varieties. Viscosity of soycorn milk varied within the range of 0.28-0.32 Pa.s. The corn varieties did not affect the viscosity of the soycorn milk. Viscosity of food system is usually affected by sugar and other macromolecules through their interaction with the solution or solvent (Zapsalis dan Beck, 1985). It is possible that the xanthan gum added at concentration of 0.02% to the soycorn milk might play an important role in the similar viscosity values observed for the three soycorn milk produced from the three different corn varieties. Fernandez *et al.* (2006) stated that stabilizer, such as xanthan gum, bind the free water therefore inhibit the water molecules mobility, and then form rigid gel structure.

Colloidal stability of the soycorn milk at different corn varieties are 100% (excellent). Omueti dan Ajomale (2005) found that corn-based beverage posses good colloidal stability. According to Nelson *et al.* (1976), the colloidal stability is determined by protein complex which are naturally presence in the soycorn milk system. It is also possible that gelatinized starch contributes to stabilize the system as argued by Iwoha and Umunnakwe (1997). This excellent colloidal stability might be also due to the presence of xanthan gum, which acts as a stabilizer in the system. This fact showed that stabilizer plays an important role to produce a stabilized soycorn milk system. This result was in line with the previous study of Lini (2010), who reported that gum xanthan at 0.02% (b/v) could retain the soycorn milk colloidal stability.

Table 1. Physical characteristics of soycorn milk at different corn varieties

Corn Varieties	Viscosity (Pa.s)	Colloidal Stability (%)
Yellow	0.28[a]	100[a]
White	0.32[a]	100[a]
Sweet	0.31[a]	100[a]

Note: different character indicated a significant difference at α = 5%

Chemical characteristics

Table 2 showed the protein content, IVPD and aflatoxin content of the soycorn milk. Normal yellow corn produced soycorn milk with highest protein content and IVPD. Concerning the safety of the soycorn milk, the HPLC results showed that aflatoxin was not detected in the soycorn milk. Figure 1, 2, 3, dan 4 showed the chromatogram of aflatoxin standard, soycorn milk with normal yellow corn, normal white and sweet yellow corn varieties, respectively. Figure 1 showed peaks of aflatoxin G_1, B_1, G_2 and B_2 appeared at retention time of 5.183; 6.354; 9.088 and 12.195 min, respectively. Figure 2, 3 and 4 showed that afltoxin G_1, B_1, G_2 and B_2 were not detected in the soycorn milk.

Table 2. Chemical characteristics of soycorn milk at different corn varieties

Corn Varieties	Protein Content (%)	*In Vitro* Protein Digestibility (%)	Aflatoxin Content (ppb)			
			B_1	B_2	G_1	G_2
Yellow	1.38	81.58	nd	nd	nd	nd
White	0.95	79.61	nd	nd	nd	nd
Sweet	1.23	78.36	nd	nd	nd	nd

Note: nd = not detected

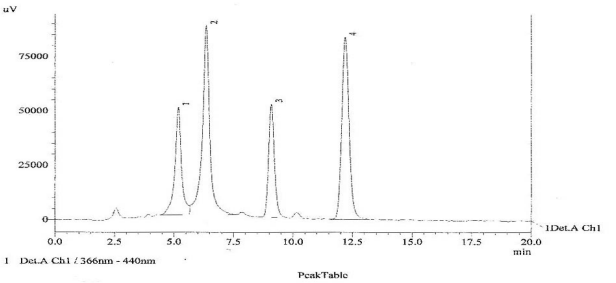

Figure 1. Chromatogram of Standard: 1 : Aflatoxin G_1; 2 : Aflatoxin B_1; 3 : Aflatoxin G_2 and 4 : Aflatoxin B_2

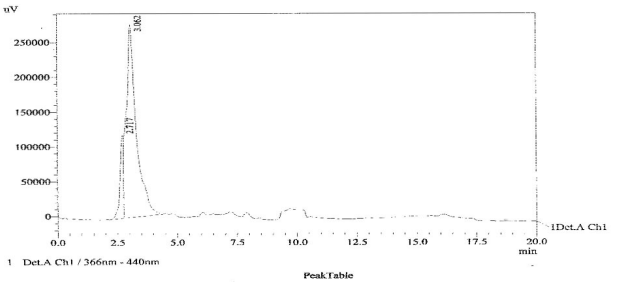

Figure 2. Chromatogram of soycorn milk at yellow corn variety

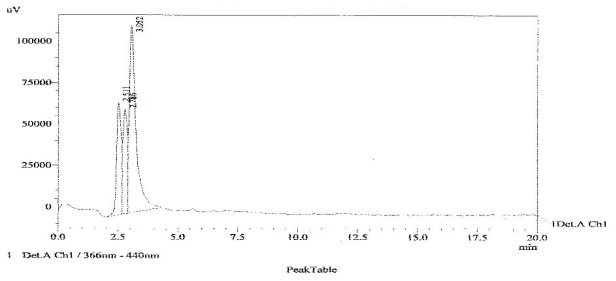

Figure 3. Chromatogram of soycorn milk at white corn variety

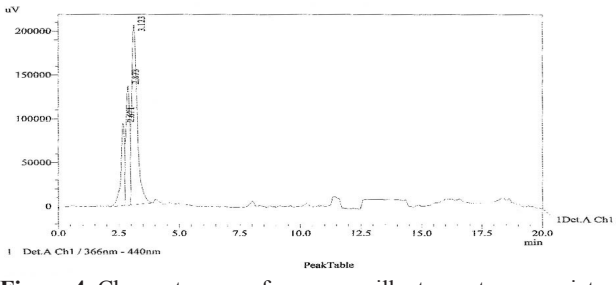

Figure 4. Chromatogram of soycorn milk at sweet corn variety

Sensory characteristics

Soycorn milk were evaluated for the colour, appearance and taste preferences. Table 3 showed the evaluation results of soycorn milk for the different corn varieties. Hedonic score from panelists varied within the range of 3.28 and 4.10. Statistically,

hedonic score of colour, appearance and taste were significantly difference for the three different corn varieties. Panelists gave high score on soycorn milk produced with normal yellow, followed by sweet yellow and normal white. Floyd *et al*. (1995) stated that yellow colour is closely related to carotene and xanthophyl content, which concurred with the results for the appearance preferences obtained in this study. Normal yellow and sweet yellow corns produce soycorn milk with taste scores higher than that of normal white. The taste of soycorn milk depends on its chemical composition and ingredients added in.

Table 3. Sensory characteristics of soycorn milk at different corn varieties

Corn Varieties	Preference Score		
	Colour	Appearance	Taste
Yellow	4.00^{c}	4.10^{b}	3.92^{b}
White	3.07^{a}	3.53^{a}	3.28^{a}
Sweet	3.59^{b}	3.67^{a}	3.81^{b}

Note: different character indicated a significant difference at $\alpha = 5\%$

Conclusion

Corn varieties did not have any effects on the viscosity and colloidal stability, but were found to affect the protein content, IVPD and preferences. Normal yellow corn produced soycorn milk with better overall characteristics than that of normal white and sweet yellow corns. Aflatoxin B_1, B_2, G_1 and G_2 were not detected in all of soycorn milks.

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