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Development of Corn Milk Yoghurt Using Mixed Culture of *Lactobacillus delbruekii*, *Streptococcus salivarus*, and *Lactobacillus casei*

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The main objective of this research was to diversify the utilization of corn as commercial commodity by a corn-based new product development in the form of yoghurt. The first step was carried out to make corn yoghurt with the addition of fresh milk into heated corn extract using mixture starter of *Lactobacillus delbruekii*, *Streptococcus salivarus,* and *Lactobacillus casei* and the best formulation was determined through hedonic evaluation along with weighing method. The selected formulation from this step was corn extract with the addition of 50% fresh milk. The corn extract was produced from corn kernels that were blended and mixed with water in ratio of 3:1, the mixture was further heated and concentrated until the total volume remained 2/3. Afterwards, this selected formulation was added with sugar and full cream milk powder. The hedonic evaluation results showed that the mixture with 10% sugar and 5% full cream milk powder addition possessed the highest score. Lastly, the selected formulation was observed for physical, microbiological, and chemical assay during 4 weeks period. The ultimate observation concluded that the product could be classified as probiotics with total lactic acid bacteria reached 1.5 x 10^9 CFU/ml with medium fat content (1.8%).

Keywords: corn milk, probiotics, yoghurt, lactic acid bacteria

INTRODUCTION

Yoghurt has become a popular fermented product for Indonesian, and it was initially invented to prolong the shelf life of fresh milk through fermentation (Tamime & Robinson 1989). Nowadays, most of the commercial yoghurts in the market are cow milk based, because of its authentic taste and aroma, and also its nutritional value which is very beneficial for health. As the consumers' awareness on health related issues increases, the current development of yoghurt based products has favored the utilization of probiotic microorganisms that is proven to promote the growth of beneficial microbes in human gastrointestinal organs (Ataie-Jafari *et al.* 2009) and resulted into several therapeutic effects (Lourens-Hattingh & Viljoen 2001) such as lowering the cholesterol level of serum cholesterol (Agerbaek *et al.* 1995; Anderson & Gilliland 1999; Agerholm-Larsen 2000), treating inflammatory bowel disease (Lorea-Baroja *et al.* 2007), preventing gastrointestinal problems, increasing mineral bioavailability and its immunological effects (Wynckel *et al.* 1991; Meydani & Ha 2000; Anukam *et al.* 2008).

Corn milk is considered as a new innovation especially in the making of yoghurt based products. It is going to be an alternative to substitute the animal based cow milk with newly introduced vegetable based corn milk. This effort is paramount to boost the domestic consumption of corn which is still considered low, while the corn production has been increasing these recent years. Based on this reason, developing a new corn based product in the form of healthy yoghurt is an avenue to raise the awareness on corn consumption. Besides, the sweet taste of corn milk along with its aroma and balanced nutritional content compared to other types of vegetable based beverage are seen as the upper hand of this product (Supavititpatana *et al.* 2008). Furthermore, the development of this product will be based on sensory acceptance so that it is expected that the product will be preferred in the market. There are several studies that emphasized a focus on cow milk. However, the number is very inadequate when it comes to the studies on corn milk yoghurt properties especially the sensory properties of corn milk yoghurt with mixed culture. This research aimed to develop yoghurt product with corn extract as functional food using mixed culture of *Lactobacillus delbruekii* subsp. *bulgaricus*, *Streptococcus salivarus* subsp. *thermophiles,* and *Lactobacillus casei* subsp. *rhamnosus*.

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MATERIALS AND METHODS

The Preparation of Sweet Corn Kernels. The sweet corn was purchased at a traditional market in Bogor. Sweet corn was chosen as the main raw materials because of its high sugar content. The whole corn was weighed to obtain the gross weight, husked, removed from the silk and finally washed. After that, the cleaned kernels were boiled with water for 10 minutes. Lastly, the corn kernels were separated from its cob to ease the extraction process.

The Preparation of Stock Culture. The mixed cultures, consisted of the strains of *S. thermophiles* FNCC0015, *Lactobacillus delbrueckii* FNCC259, and *Lactobacillus casei* subsp. *rhamnosus* FNCC099, were obtained from Food Nutrition and Culture Collection, Center for Food and Nutrition Studies, Gadjah Mada University. The culture stock was grown on MRS chalk semi solid (oxoid) media and incubated at 43-45 °C incubator for 24 h. Afterwards, the stock culture was stored in refrigerator at 5 °C. A loop of microorganism was taken from the media and inoculated on MRS broth (oxoid) and further incubated at 43-45 °C for 24 h and stored in refrigerator at 5 °C. Around 0.5% (v/v) of inoculums was transferred to 50 ml of sterilized mixture containing 10% (w/v) of skim milk powder. This mixture was incubated again at 43-45 °C for 24 h. This mixture was referred as stock culture and was kept in refrigerator prior to the usage (Hariyadi 2001).

The Preparation of Mother Culture. The mother culture was prepared by transferring 5% of stock culture to 50 ml of sterilized mixture containing 10% (w/v) of skim milk powder. This mixture was incubated again at 43-45 °C for 24 h. This mixture was referred as mother culture and was kept in refrigerator prior to the usage (Hariyadi 2001).

The Mixing of Corn Extracts and Fresh Milk (Step I). The corn kernels were blended with water using the ratio of 4:1 and 3:1 (v/w), and then filtered to get fine solution. The extract with 4:1 (v/w) ratio was heated at 70-80 °C with appropriate stirring until the total volume remained half of initial volume. Another extract with 3:1 (v/w) ratio was processed in two different ways i.e. heated at 70-80 °C with appropriate stirring until the total volume reached ⅓ and ⅔ of initial volume. After that, fresh milk with concentration of 50, 30, and 10% (v/v) were added into each extract so that there were nine formulations obtained (Table 1). Out of these formulations, the best formula was determined using sensory evaluation with hedonic assay method.

The Addition of Sugar and Reconstituted Milk Powder (Step II). After the basic formulation from Step I had been selected, the formulation was then added 6, 8, and 10% (w/v) sugar and 5% of both skim milk and full cream milk powder. Subsequently, the mixture gained from each formulation was homogenized and pasteurized at 80-90 °C for 15-20 min and eventually cooled at 45 °C. Thus, there were 6 formulations resulted from Step II. Subsequently, 5% (v/v) of yoghurt starter culture consisted of *S. thermophilus*, *L. bulgaricus*, and *L. caseiatwitha* ratio of 1:1:1 was inoculated to each formulation. Each inoculum was incubated at room temperature for 24 h and stored in refrigerator at 5 °C. Each formulation (Table 2) was later analyzed by sensory evaluations to get the best final formulation.

The Sensory Evaluations. The sensory evaluation for formulations in step I and step II was conducted by following hedonic scale rating test using 30 untrained panelists. The panelists were asked to score the samples for preference of corn milk yoghurt characteristic on a scale of 1 to

Table 1. Formulation used to make corn yogurt in step 1

Composition/Treatment	Formulation								
	a1	b1	c1	d1	e1	f1	g1	h1	i1
Water to corn extract ratio	3:1	3:1	3:1	4:1	4:1	4:1	3:1	3:1	3:1
Remaining volume (from the initial volume)	1/3	1/3	1/3	1/2	1/2	1/2	2/3	2/3	2/3
Fresh milk added (v/v)	50%	30%	10%	50%	30%	10%	50%	30%	10%

Table 2. Formulation used to make corn yogurt in step 2

Composition	Formulation					
	a2	b2	c2	d2	e2	f2
Sugar (w/v)	6%	8%	10%	6%	8%	10%
Full cream milk powder (w/v)	5%	5%	5%	-	-	-
Skim milk powder (w/v)	-	-	-	5%	5%	5%

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