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FULL LENGTH ARTICLE

Functional and rheological properties of composite flour from sweet potato, maize, soybean and xanthan gum

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Abstract Sweet potato flour (SP), maize starch (MS), and soybean flour (SF) blends were prepared in different proportions like: 60SP/20MS/19.5SF; 50SP/30MS/19.5SF; 40SP/40MS/19.5SF; 50SP/20MS/29.5SF; 40SP/20MS/29.5SF; and 30SP/40MS/29.5SF. The constant percentage of xanthan gum at 0.5% was added to each blend. Functional and rheological properties of the composite flour were examined and compared with wheat flour as control. Oil absorption index was not significantly different ($P > 0.05$) among the six blends of composite flour and wheat flour. As increasing of soybean flour levels, swelling power, and pasting viscosity of composite flours decreased, specific volume of bread also decreased as decreasing of soybean flour level in composite flours, but the firmness of bread increased. Physical and sensory analysis showed that composite flour with the proportion of sweet potato flour 40%, maize starch 40%, soybean flour 19.5% and xanthan gum 0.5% yielded acceptable breads.

1. Introduction

Production of baked products such as bread, cakes, buns, doughnuts, and biscuit generally used wheat flour, as a result of the nature and functional properties of the wheat flour proteins. But local climatic conditions in tropical countries such as Indonesia are not suitable for profitable wheat production, and consequently, Indonesia has been completely dependent on imported wheat for manufacture of baked products. For this reasons, the research focused on composite flour from local crops to replace wheat. Composite flour was defined as a mixture of several flours obtained from roots, tubers, cereals and legumes with or without the addition of wheat flour (Adeyemi and Ogazi, 1985; Shittu et al., 2007). Composite flours have been used extensively and successfully in the production of baked foods. Some studies were reported on the use of cereal-tuber-legume combination for the production of various products (Akubor and Ukwuru, 2005; Oladunmoye et al., 2010). It can be deduced from these reports that the qualities of product depend on the proportional composition

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of the composites and flour properties (Oladunmoye et al., 2010). Composite flour had a few advantages for developing countries such as Indonesia as it reduces the importation of wheat flour and encourages the use of domestic agricultural products as flour (Hugo et al., 2000).

Sweet potato ranks the seventh most important food crop in the world and fourth in tropical countries (FAOSTAT, 2004). It is a low input crop, wide production geography, adaptability to marginal condition, short production cycle, high nutritional value and sensory versatility in terms of flesh colors, taste and texture. Depending on the flesh color, sweet potatoes are rich in β-carotene, anthocyanins, total phenolics, dietary fiber, ascorbic acid, folic acid and minerals (Woolfe, 1992; ILSI, 2008). Although sweet potato had many positive attributes and was cheaper than other crops, this abundant resource is still poorly utilized. The development of appealing processed products from sweet potatoes will play a major role in raising awareness on the potential of the crop.

Corn is considered as one of the principle crops in Indonesia and its production is increasing yearly; however, it is mainly used for animal and poultry feeding, in spite of the shortage in the cereal-based foodstuffs. Soybean is an excellent source of protein (35–40%), rich in calcium, iron, phosphorus and vitamins, and also the only source of all the essential amino acids (Ihekoronye and Ngoddy, 1985). Soybean proteins are rich in lysine but deficient in sulfur containing amino acids, whereas cereal proteins are deficient in lysine, but have adequate amounts of sulfur amino acids (Eggum and Beame, 1983). Addition of soybean flour to cereal based products could be a good option to provide better overall essential amino acid balance, helping to overcome the world protein calorie malnutrition problem (Livingstone et al., 1993). Soybean flour and soybean protein have been used as composite flour in the production of bread (Dhingra and Jood, 2001; Basman et al., 2003; Ribotta et al., 2004; Sanchez et al., 2004; Moore et al., 2006), cookies and biscuit (Shrestha and Noomhorm, 2002; Akubor and Ukwuru, 2005), and pasta (Ansari et al., 2013; Doxastakis and Papageorgiou, 2007).

It is important to note that baked products such as bread similar to wheat bread cannot be obtained from non-wheat flour, due to deficiency of gluten, a viscoelastic protein. Gluten in wheat flour has a fundamental role in bread making, as it is an essential structure-building protein that provides viscoelasticity to the dough, good gas-holding ability and good crumb structure of the resulting baked product (Gallagher et al., 2003). Addition of hydrocolloids such as xanthan gum is the most important approaches developed to mimic the properties of gluten in gluten-free bakery products (Moore et al., 2006; Lazaridou et al., 2007; Arendt et al., 2008; Alvarenga et al., 2011). Xanthan gum is an extracellular polysaccharide produced by bacterium *Xanthmonas campestris* (Achayuthakan and Suphantharika, 2008). It is commonly used with emulsifier to develop non-gluten bread, bread rich in proteins, bakery fillings, syrup glazings, desserts and milk products, and cakes, to stabilize emulsions and to improve stability of frozen dough at concentration of 0.1–0.25% (Guarda et al., 2004; Gomez et al., 2007; Arocas et al., 2009; Makri and Doxastakis, 2006).

The objective of this research was to study the effect of proportion of sweet potato flour, maize starch, and soybean flour for the production of composite flour and applying the hydrocolloid xanthan gum compared with wheat flour (as control).

2. Materials and methods

2.1. Materials

White tuber varieties of sweet potato and anjasmoro variety of soybeans are obtained from local market in Medan. Commercial maize starch and wheat flour procured from PT.Budi Makmur Perkasa Indonesia and PT.Indofood Sukses Makmur Tbk. Indonesia, respectively. Xanthan gum (G1253, Sigma–Aldrich USA) was procured from PT.Elo Karsa Utama (Jakarta, Indonesia). Other ingredients for baking bread were purchased from a local market in Medan, Indonesia.

2.2. Preparation of sweet potato flour

Sweet potato tubers were washed, peeled and cut into thin slices, spread in a tray and was oven dried at 60 °C for 10 h and after which it was milled into flour. The flours were screened through a 80 mesh sieve, and then stored in polyethylene bags before using.

2.3. Preparation of full fat soybean flour

Soybean grains were selected, washed and soaked into water for 6 h and then boiled in pressure cooker for 5 min. They were removed, dehulled and dried in the oven at 50 °C for 24 h after which they were ground into flour in an electric grinder. The flour was sieved through 80 mesh sieve. The flour samples were kept in airtight container before using. Packaging of flour samples differs between sweet potato and soy bean, because of the higher fat content in soy flour, so it is necessary to be in airtight container.

2.4. Composite flour preparation

The six different intervals of sweet potato flour, maize starch, and soybean flour (Table 1) are used in composite flours. Xanthan gum was added to the composite flours at 0.5% by total weight. Sweet potato flour (SPF) was blended with maize starch (MS), soybean flour (SF) and xanthan gum (XG) by using a mixer. The composite flour samples were stored in airtight container. Ingredient and composite flour samples were analyzed for functional and rheological properties. Wheat flour (WF) was used as control flour.

2.5. Functional properties of composite flours

The functional properties of individual and composite flour such as water absorption index (WAI), oil absorption index

Table 1 Different treatment used to prepare composite flour.

Treatment	Sweet potato flour (%)	Maize starch (%)	Soybean flour (%)
T_1	60	20	19.5
T_2	50	30	19.5
T_3	40	40	19.5
T_4	50	20	29.5
T_5	40	30	29.5
T_6	30	40	29.5

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