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RESEARCH PAPER

Cassava: Extraction of Starch and Utilization of Flour in Bakery Products

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ABSTRACT

Cassava (*Manihot esculenta* Crantz) is the third largest carbohydrate food source in the tropical region, after rice and corn. Cassava is considered as a food security crop which can be left in the ground for extended periods of up to two years, until required. Cassava was procured from the Department of Vegetable Science, Punjab Agricultural University. Starch was extracted from cassava by peeling, chopping, grinding with water for 5 minutes, filtration, decantation and drying at 55°C for one hour. Percentage of starch obtained was 25%. Flour was prepared from cassava by peeling, grating, drying in hot air oven at 55°C for 24 hrs and then, milling. Percentage of flour obtained was 40% while that of flour after extraction of starch was 12 %. Different blends were prepared with wheat flour, soy flour, cassava flour in the ratio of 90:5:5, 85:5:10, 75:10:15 and 70:10:20, respectively and their baking quality for preparation of cookies was evaluated. The blend with wheat flour, soy flour, cassava flour in the ratio of 85:5:10 was found to be the best with regard to baking and sensory quality. It was concluded that cassava can be utilized in the form of flour in bakery products, as a replacement of wheat flour in gluten free diets and for starch, as the demand of starch for various food and non-food purposes is increasing.

Keywords: Cassava, Starch, Cassava flour, Soy flour, Extraction

Cassava (*Manihot esculenta* Crantz) is a perennial, subtropical crop which is valued for its underground starchy tubers (roots) (Grace, 1977; Purseglove,1988; Islam *et al*., 2008). It is a starchy root crop grown mostly in the hotter low land tropics and is an important source of energy as a staple food for more than 500 million people in Africa, Latin America and Asia (Hillocks, 2002). Tuber of cassava is also used as raw materials in the garment, bakery, food and pharmaceutical industries (IITA, 2011; Fakir *et al.*, 2012). It is a hardy crop that grows under marginal conditions (draught or depleted soils). Though described as an inferior source of nutrients because of its low protein content and poor protein quality, and because of its cynogenic glucoside content (Hahn and Keyser, 1985; Cooke and Coursey, 1981), yet most of the total world production of cassava is processed for human consumption directly as food or indirectly as a feed for livestock, and its food quality is generally improved through processing.

Cassava tuber is the main source of starch and minerals, its flour (10-30%) in combination with wheat flour are used in bread industry to reduce pressure on wheat (Grace, 1977). Therefore, cassava flour as a mixture with wheat flour can be used to make nutritious food and food products. Its tuberous root contains 30-40% dry matter and 25-30% starch. Nutritionally, cassava contains potassium, iron, calcium, vitamin A, folic acid, sodium, vitamin C, vitamin B-6 and protein (Montagnac *et al*., 2009). Nutritional quality especially protein can be added in composite flours in cassava-soya, cassava-peanut bread. There is much variation in the nutrient quality of the cassava root (Chaves *et al*., 2005). In the tropical regions, cassava is the most important root crop and, as a source of energy, the calorific value of cassava is high, compared to most starchy crops (Okigbo, 1980). The starch content of the fresh cassava root is about 30% and gives the highest yield of starch per unit area of any crop known (Tonukari, 2004). The protein content is extremely low, however, and ranges between 1-3% (Buitrago, 1990; Salcedo *et al*., 2010). The cassava root contains significant amounts of iron, phosphorus and calcium and is relatively rich in vitamin C (Enidiok, *et al*., 2008).

The possibility of using starchy tubers instead of wheat flour in foods depends on their chemical and physical properties. Amylose/amylopectin ratio influences the flour's behavior in food systems such as viscosity, gelatinization and setback which affect the texture of the end product. However, to be widely accepted by the food industry, cassava flour needs to meet the high quality requirements in terms of physico-chemical characteristics, microbial safety and presence of toxic cyanogenic glucosides. Since cassava flour is deficient in proteins and to maintain the nutritional balance, soy flour was blended with cassava flour. In bakery products, the absence of gluten and the acceptability of the end products among the consumers in terms of sensory attributes are important issues to be considered. The aim of this study was to determine maximum inclusion level of cassava flour in composite wheat/cassava/soya flour in bakery products such as cookies without any significant changes in baking capacity and sensory attributes compared to 100% wheat products. The present study was designed to standardize the procedure for extraction of starch from cassava and utilization of cassava flour in bakery products.

MATERIALS AND METHODS

Raw materials

Cassava roots were procured from Department of Vegetable Science, Punjab Agricultural University, Ludhiana. Other raw material used in the study was procured from the local market.

Extraction of starch

Fresh tubers were washed, peeled, chopped into approximately 1 cm cubes and then ground in a high speed blender for 5 min (Fig. 1.). The pulp was suspended in ten times its volume of water, stirred for 5 minutes and filtered using double fold cheese cloth. The filtrate was allowed to stand for 2 hr for the starch to settle and the top liquid was decanted and discarded. Water was added to the sediment and the mixture was stirred again for 5 minutes. Filtration was repeated as before and the starch from filtrate was allowed to settle. After decanting the top liquid, the sediment (starch) was dried at 55^{o}C for one hour.

Cassava tubers
↓
Peeling
↓
Washing
↓
Grating/Grinding
↓
Mixing with water
↓
Filtering/screening
↓
Settling
↓
Starch washing
↓
Settling/dewatering
↓
Drying
↓
Milling
↓
Cassava starch

Fig. 1: Extraction of starch from cassava tubers

Preparation of Cassava flour: Fresh tubers were washed, peeled and grated (Fig. 2.). Grated tubers were dried in hot air oven at 55°C for 24 hrs. Dried grated cassava was ground and packed in high density polyethylene for further use.

Harvesting tuber
↓
Cleaning/Washing
↓
Peeling
↓
Slicing/grating
↓
Pressing
↓
Disintegration
↓
Drying in hot air oven
↓
Milling/Grinding
↓
Sieving
↓
Cassava Flour

Fig. 2: Preparation of flour from cassava tubers

Baking: For product making Standard AACC method (Anon, 1990) was followed using following ingredients:

Ingredients	Quantity (g)
Flour	100
Sugar	58
Salt (NaCl)	0.9
Sodium bicarbonate	1.0
Shortening	28
Dextrose	13.8 ml (8.9 g glucose in 150 ml water)
Water	Optimum (ml)

Cookies were prepared by blending wheat flour, soy flour and cassava flour in different ratios as given in Table 1.

Dough was prepared, sheeted (5 mm) and cut into circular cookies (diameter 5.5 cm) and baked for 10 min at 400°F.

Different blends of wheat flour, soy flour and cassava flour made were in the ratio of 90:5:5, 85:5:10, 75:10:15 and 70:10:20 respectively and their baking quality for preparation of cookies was evaluated.

Physico-chemical and sensory evaluation

Prepared cookies were evaluated for spread ratio by determining Width of cookies by taking average of width of 3 cookies; simultaneously thickness was determined by taking average of thickness of three cookies. Cookie spread ratio was calculated by having ratio of average width to thickness for 3 cookies at a time. Cookies were scored for appearance, flavor, mouthfeel and overall acceptability by panel of six semi-trained judges on a nine point hedonic scale.

Statistical Analysis

Analysis of variance (ANOVA) was used for statistical analysis of data (Gomez and Gomez, 2010).

RESULTS AND DISCUSSION

Extraction of starch from Cassava

Percentage of starch obtained was 25 % while the percentage of flour obtained was 40% and percentage of flour after extraction of starch was 12 %.

Effect of different blends on cookie making quality

The effect of various blends of wheat flour, soy flour, cassava flour in the ratio of 90:5:5, 85:5:10, 75:10:15 and 70:10:20, respectively was evaluated for their baking quality regarding preparation of cookies (Table 1)

Table 1: Effect of various blends of wheat flour, soy flour and cassava flour on cookie making quality

Wheat: Soya: Cassava flour Blends	Yield (g/100g)	Width (cm)	Thickness (cm)	Spread Ratio
90:5:5	183.3	25.9	3.6	7.19
85:5:10	183.2	25.4	3.4	**7.47**
75:10:15	181.5	24.9	3.9	6.38
70:10:20	180.4	24.9	4.1	6.07
Control	182.0	26.5	3.5	7.57
CD (0.05)	**NS**	**0.11**	**0.10**	**0.12**

Yield of cookies varied non-significantly at various levels. Width of cookies was found to decrease with increase in level of cassava flour as compared to the control. Thickness of cookies was found increasing with increase in level of cassava flour. Spread ratio was the highest among blends of 85:5:10. Oyewole (2002) studied that cassava flour can be effectively substituted for wheat flour in biscuits. High quality cassava flour can substitute for up to 30% of wheat flour in sweet dough biscuit and 40% in hard dough biscuit, without consumers being able to detect any adverse change in color, taste or texture when compared to 100% wheat flour control. Abbas *et al.* (1998) reported that consumers found the biscuits containing more than 40% cassava flour to be less crispy, bland in flavor and susceptible to crumbling.

Effect of different blends on sensory quality of cookies

Statistically significant variations were recorded for sensory quality i.e. appearance, flavor, mouthfeel and overall acceptability of cookies prepared from different blends of wheat flour, soy flour and cassava flour in the ratio of 90:5:5, 85:5:10, 75:10:15 and 70:10:20, respectively (Table 2.) Panelists awarded more scores for appearance, flavor, mouthfeel and overall acceptability for cookies prepared with 85:5:10 blend.

Table 2: Effect of various blends of wheat flour, soy flour and cassava flour on the Mean Panel Scores (Max 9) for sensory evaluation of cookies

Wheat: Soya: Cassava flour Blends	Appearance	Flavor	Mouthfeel	Overall Acceptability
90:5:5	8.33	8.5	8.41	8.41
85:5:10	8.55	8.75	8.50	**8.58**
75:10:15	8.00	8.16	8.00	8.14
70:10:20	7.58	8.08	8.00	7.91
Control	8.08	7.25	7.25	7.52
CD (0.05)	0.13	0.18	0.11	0.11

On the basis of cookie making quality and sensory quality, the second blend i.e. wheat flour, soy flour and cassava flour in the ratio of 85:5:10 was selected as the best for baking quality of cookies.

CONCLUSION

Cassava is less labor intensive crop and able to grow on marginal soils. It can be utilized for starch and flour in bakery products. Yield of starch obtained was 25 per cent and flour is 40 per cent. The present study demonstrated that cassava flour can be utilized for preparation of cookies up to 10 per cent level with acceptable sensory attributes. The finding of this study may help generate technology to diversify the use of cassava by the food processing enterprises, especially starch and baking industries.

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