Quality Evaluation of Bread Containing Unripe Apple or Banana Flour

Tamio MASE*, Yuuka SATO*, Sayuri MIYAZAKI*, Yoshiho KATO* and Shinobu ISSHIKI*

Abstract

We have examined the processing of bread in which a proportion of the wheat flour was replaced with unripe banana or apple flour. The wheat flour and fruit flour were blended and baked, and the effects of the unripe fruit flour on properties such as dietry fiber content and antioxidant activity were investigated.

Breads made with fruit flour were lower in specific loaf volume than conventional wheat bread. Antioxidative activity, defined as 1,1-diphenyl-2-picrylhydrazyl scavenging activity, was significantly increased. The dietary fiber content, including soluble dietary fiber (SDF) and insoluble dietary fiber (ISF), was also increased. Banana flour did not affect the panelists' preference, but unripe apple flour had a negative effect. This study shows that unripe fruit flour is effective as a physiological functional additive for bread.

Introduction

More than eight million tons of apples are produced every year in Japan. During apple production, apples are thinned at an early stage of fruit development to enhance fruit growth and quality, and reduce alternate bearing. Apple thinnings have a high polyphenol content and a high dietary fiber content. In order to use the apple thinnings effectively, we investigated the addition of unripe apple to bread, in order to enhance the physiological function of bread with polyphenols and dietary fiber.

Polyphenolic compounds[1)] have been intensively studied because of their physiological activities (e.g., anti-atherosclerotic and antiallergic activities), which arises from their antioxidative properties.[2, 3)]

Dietary fiber has been reported to be important in human nutrition. Several diseases such as appendicitis and colon cancer are thought to be associated with the consumption of refined, carbohydrate-rich foods.[4)] Dietary fiber is also believed to have a beneficial effect on colonic

* *School of Life Studies, Department of Human Nutrition*

function.

Despite the high content of functional substances in unripe apples, they have not been used commercially in food because of the unpleasant taste. A small amount of polyphenols prepared from unripe apple is used in nutritional supplements, but they have never been used in breadmaking. Increasing the dietary fiber and polyphenol content in bread products would be beneficial for bread consumers, especially for prevention of cancer of the colon.

Unripe bananas are also expected to have similar properties to unripe apples. Unripe banana has previously been mixed with semolina to prepare healthful pasta. Consumers showed no difference in preference for the spaghetti containing banana flour compared with conventional pasta.[5)]

Herein we report fruit breads in which unripe fruit flours were added to the wheat flour, and the characteristics of these breads are compared with those of white bread as a control.

Materials and Methods

Experimental materials. Wheat flour (Camellia) and dry yeast (Super Camellia) were purchased from Nisshin Flour Milling Co., Ltd., Tokyo, Japan. Ripe and unripe bananas (*Musa acuminata*) were harvested from a farm in Thailand and unripe apples (*Fuji*) were purchased from Hiramatu Orchard, Nagano Prefecture, Japan. Ripe banana was used as the control for unripe banana. Other chemicals used were analytical grade.

Preparation of banana or apple flour. Slices (3 mm) of peeled, unripe banana were sun-dried, and slices (3 mm) of peeled, ripe banana was freeze-dried. Unripe apple (Fig. 1, Φ 3.5 to 4.0 cm) was freeze dried after the core was removed. The dried fruit were milled with a Wonder Blender WB-1 (Osaka Chemical Ltd., Japan) and passed through a 500 μm sieve. The flour was stored at −5°C and used within 3 days.

Fig. 1. Unripe apples and golf ball

Antioxidative activity. A spectrophotometric assay for 1,1-diphenyl-2-picrylhydrazy (DPPH)-radical scavenging activity was used to determine the antioxidative activity.[6)] The sample solution (0.3 mL) dissolved in 80% ethanol was added to a reaction mixture containing a solution of DPPH in ethanol (400 μM, 0.3 mL), MES buffer (200 mM, 0.3 mL) and 20% ethanol (0.3 mL). After

20 min, the absorbance of the reaction mixture was measured at 520 nm. The DPPH scavenging activity was estimated by the decrease in the absorbance at 520 nm, and expressed as nmol-Trolox equivalent per mL of sample solution using the standard curve for Trolox.

Total phenolic content. The total phenolic content was determined using the Folin-Denis method[7] with gallic acid as a standard.

Assay of dietary fiber. The soluble dietary fiber (SDF) and insoluble dietary fiber (ISF) content were measured by using the modified enzymatic-gravimetric method.[8]

Breadmaking. The tests for breadmaking were carried out using the no-time straight dough method used in standard white bread production according to the following formula: wheat flour (300 g), butter (10 g, Snow Brand Milk Products Co., Ltd. Japan), sucrose (30 g, Itochu Sugar Co., Ltd. Japan), NaCl (5 g, Hakata Salt MFG Inc. Japan), dry yeast (6 g) and of water (160 mL). For the fruit flour bread, a 75 g portion of the wheat flour was replaced with 75 g fruit flour. The ingredients were mixed and fermented in an automatic breadmaker SD-BT50 (Matsushita Electric Industrial Co., Ltd.) using the standard bread-dough preparation conditions described in the maker's manual. The dough was allowed to rest at 28°C for 10 min, and was then punched lightly seven times. The dough was divided into 42 g portions which were rounded by hand, and proofed for 30 min. Each portion was put into a microwave oven fermentor RO-EL2 (Mitsubishi Electric Corporation) for a second fermentation at 30°C for 40 min, and then baking at 180°C for 15 min.

Measurement and evaluation of bread properties. The bread was allowed to stand at 23°C for 1 h before the specific loaf volume (SLV) was determined with the rapeseed displacement method. The SLV (mL/g) was calculated by using the following equation:

SLV = volume of bread (mL) / weight of bread (g).

The loaf color (L^*, a^*, b^*) of the bread was measured with a Hunter color difference meter NE 2000 (Nippon Denshoku Industries Co., Ltd.). The firmness was measured with Texturometer TPU-2C (Yamaden Co., Ltd.) by measuring the compression force on bread slices (20 mm × 20 mm × 20 mm) with Ultrasonic wave cutter USC-3305 (Yamaden Co., Ltd.). The cube of bread was compressed at a speed of 2.5 mm/s with a plunger (Φ 16 mm). The loaves were sliced in half and the inner part of the loaf was examined visually.

The sensory characteristics of the various breads were evaluated by a panel of 10 students at Sugiyama Women's University.[9]

Results and Discussion

Baking quality. The specific loaf volume (SLV) of the breads is shown in Fig. 2. Breads with fruit flour, especially the unripe apple, had a far lower SLV than the conventional wheat flour control bread. When wheat flour was partially substituted by unripe apple flour the bread appeared smaller than that of the control bread, and it was also the heaviest and the firmest of the loaves tested (Table 1). This is because fruit flours have a high unfermentable sugar content (data not shown) compared with wheat flour, which results in low yeast growth and CO_2 gas production, and therefore a reduction in bread expansion. Additionally, the low SLV of unripe apple bread suggests

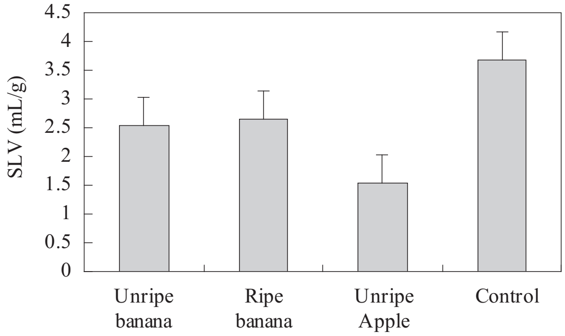

Fig. 2. Specific loaf volume (SLV) of breads*

* Values are mean ± SD, n = 5.

Table 1. Color and firmness of bread

Bread	Color			Firmness*
	L^*	a^*	b^*	(× 10^4 N/m^2)
Control (wheat)	72.80	12.06	28.20	0.66 ± 0.07
Unripe banana	38.67	8.08	13.65	0.85 ± 0.04
Ripe banana	39.41	7.22	14.01	1.17 ± 0.04
Unripe apple	80.77	−1.78	27.03	7.85 ± 0.09

* Values are mean ± SD, n = 3.

that the pH of apple flour is too low for sufficient yeast growth. The SLV could be improved by the addition of fermentable sugars and a pH regulator.

DPPH scavenging activity. The DPPH-radical scavenging activity of breads is shown in Fig. 3. In the preliminary test of the preparation of banana flour with ripe banana, the drying method did not affect the antioxidative activity (data not shown). The antioxidative activity of fruit flour breads was significantly higher than that of the control bread and it is proportional to the total phenolic contents of original flour (data not shown).

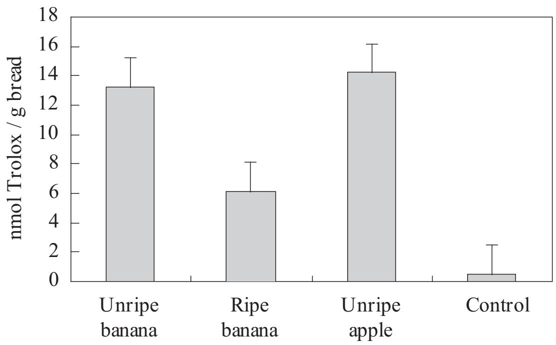

Fig. 3. DPPH-radical scavenging activity of breads*

* Values are mean ± SD, n = 5.

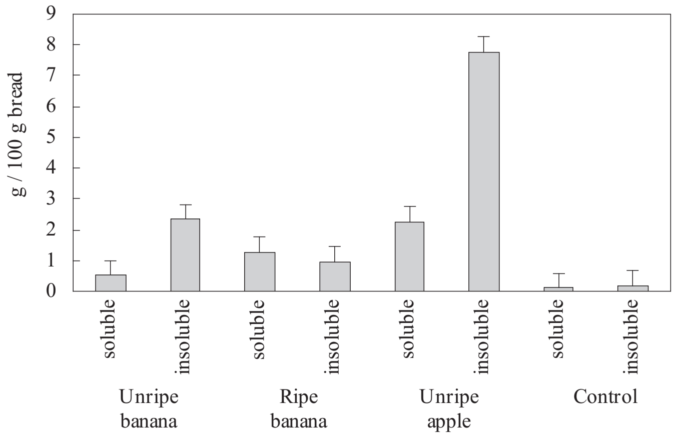

Fig. 4. Dietary fiber in breads*

* Values are mean ± SD, $n = 3$.

Assay of dietary fiber. The SDF and ISF content of breads is shown in Fig. 4. Fruit flour breads had a higher total dietary fiber content than the control bread. The unripe apple flour was the most effective for increasing the SDF and ISF content. The unripe banana bread had a high ISF content and a low SDF content, whereas the opposite was true for ripe banana bread. The ISF therefore appears to be converted into SDF by enzymes in the banana during ripening. There is an extensive body of research which indicates the importance of dietary fiber in human nutrition; unripe fruit flour bread could increase the amount of fiber in the diet.

Sensory evaluation of breads with fruit flour. The sensory attributes and palatability of three types of fruit flour bread were compared with those of the control bread. The results of sensory characteristics are shown in Table 2. The control bread was preferred by panel with respect to taste, color and flavor. The total evaluation of breads showed that the bread with ripe banana flour and the control bread had a similar score. However, the panelists rated the bread with apple flour lower than the other breads ($p<0.05$). The crumb and crust color of the breads with banana flour was browner than the control bread. The apple flour bread had a green color and a sour taste (Table 1). The green color originates from the green color of peel and sour taste is from the organic acid in the flesh. The SLV (Fig. 2) and firmness (Table 2) is related to the hardness in the sensory evaluation (Table 1).

Table 2. Sensory evaluation of round arch type bread with fruit flour

Bread	Palatability						
	Color	Flavor	Smoothness	Hardness	Elasticity	Taste	Total
Control (wheat)	15	16	22	20	25	18	18
Unripe banana	27	27	20	21	26	26	25
Ripe banana	27	27	27	25	24	22	17
Unripe apple	29	30	31	32	25	34*	40*

Ten panelists ranked the round arch type breads according to their palatability. Differences among the total scores evaluated by Kramer's test. Significant difference, *$p<0.05$.

Conclusions

We found that the addition of fruit flour in bread increased the dietary fiber content and antioxidative activity. Unripe apple flour showed the greatest increase in fiber and antioxidative activity, although the sensory evaluation of unripe apple bread by the panel was not favorable in terms of color, flavor and taste. If unripe apple flour is to be used as an additive in breadmaking, it requires the development of additives to improve the palatability of the bread.

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