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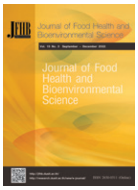

The Use of Fruit Yeast as a Substitute for Instant Yeast in Sweet Bread Products

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Abstract

This study aimed to solve the problem of fruit wastage through the following objectives: (1) create usage for food waste materials from the food industry, (2) study the process of yeast fermentation from fruits and (3) study the physical properties of sweet bread. The ability to form yeasts was studied using a total soluble solid (TSS) (°Brix). TSS decreased, indicating the amount of yeasts formed. Fermented sugarcane contained more yeast than fermented apple based on the TSS of sugarcane and apple fermented broths on the third day, which decreased by 50.85% and 34.5% ($p \leq 0.05$), respectively, while instant yeast decreased by 79.2%. The culture broth yeast was used as a substitute for instant yeast in sweet bread products. The physical properties of the bread were studied by volume, specific volume, density and texture profile analysis. The use of yeast from sugarcane and apple had a decreased volume that resulted in a decrease in specific volume by an average of 13.29% and 28.33%, respectively and had more density and more rigid texture than instant yeast ($p \leq 0.05$). Thus, consumers who are allergic to instant yeast powder now have an alternative with the bread produced from fermented fruit yeast.

Introduction

Food waste includes leftover food from meals and industrial plants. This accounts for 1.3 billion tons of food waste annually or 30% of the world's food production (Gustavsson et al., 2011). In 2017, food wastage in Thailand was as high as 6.96 million tons (FAO, 2017) and fruits and vegetables comprised around 40%-50% of these losses. Currently, food waste from production is used to produce additional products. For instance, insect food (Halloran et al., 2017) and biofermented water (Chanvichit, 2019) are used as ingredients for animal food and bread product development from fruit waste (Horthong et al., 2014). Yeasts are organisms that can be beneficial or harmful to food. Yeast fermentation is critical in many foods, including bread, beer, wine and vinegar. The most widely used species is *Saccharomyces cerevisiae.* Bread yeast is used to flavor food, with some yeast extracts having a distinctive smell and high sodium content. Yeasts should only be eaten in small quantities (Horthong et al., 2014). Some yeast grows in cultured media. The

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production costs of yeast cultures are quite high and there are many necessary production steps. Instant yeasts are also expensive.

This study aimed to introduce natural yeast obtained from fruit fermentation. This involved using ripe fruits or fruit peels as a substitute for instant yeasts in sweet bread products. Prior research showed that fruit yeasts have the same ability to leaven bread as instant yeasts (Tsegaye et al., 2018). Bread made from fermented fruit yeasts is an alternative for consumers who are allergic to instant yeast powder. It increases the amount of probiotics in bread and reduces the cost of bread production.

Materials and methods

1. Preparation of the Bread Recipe

The ingredients to make a bread consisted of the following (Iampitakkit, 2019): bread flour (1,000 g, White swan, Thailand), evaporated milk (200 g, Carnation, Thailand), water (300 g), sugar (125 g, Mitrphol, Thailand), butter (175 g, Orchid, Thailand), gluten (20 g, Bangkok flour & food trading, Thailand), instant yeast (15 g, Fermipan, Canada), salt (15 g, Prungthip, Thailand), emulsifier (10 g, Bacom A100, Bakels, Malaysia) and two eggs. The ingredients were kneaded in a dough-kneading machine for 20 min. The prepared dough was made into 40 g, round buns and stored in a temperature-controlled cabinet at 35°C for 75 min. The buns were then baked at 170°C for 20 min.

2. Fruit yeast preparation

Yeast fermentation was studied using two fruits: bagasse and apple. The fruits were prepared by washing and trimming the rotten parts before soaking in water for 24 h and then dried. Raw materials were prepared for fruit yeast fermentation. The water, fruit and sugar ratios for fermentation were 50:25:8, respectively. Water and sugar were placed in a sterilized jar. Then, the total soluble solids (TSS) were measured at 20 °Brix, adding fruits. Finally, the jar was shaken and moved to a temperature-controlled cabinet set at 32°C for three days.

3. Study of yeast fermentation

Fruit yeast was used to study the characteristics of yeast produced by yeast count using the spread plate technique on the surface of sterile potato dextrose agar. The potato dextrose agar was incubated at 37°C for two days to study the morphology of colony growth on solid food cell shape, following the method of Barnett et al. (2000). Next, the amount of yeasts produced was determined by measuring the TSS in comparison with soluble solids in the initial solution. Comparatively, the amount of TSS decreased and bubbles formed in the container.

4. Physical properties of sweet bread made from fruit yeast

The use of fruit yeast as a substitute for instant yeast in sweet bread was studied. Culture broth yeasts were replaced by all water and instant yeasts in sweet bread recipes (100%). Then, the physical properties of natural yeast bread were studied. Finally, it was compared with instant yeast bread.

4.1 Bread specific volume

The volume was analyzed by replacing sesame seeds, following the AACC method 10–05 (AACC., 2000). Sesame seeds were poured into an empty container (V1) to determine its capacity. Then, whole bread was placed inside it and sesame seeds were added to the remaining space in the container (V2). A graduated cylinder was used to calculate V1 and V2. The difference between the two was used to determine the bread volume. The specific volume was calculated from the bread volume to bread weight ratio (Eq. 1).

$$\text{Specific Volume } (\text{cm}^3/\text{g}) = \frac{\text{Bread volume } (\text{cm}^3)}{\text{Bread weight (g)}} \quad \text{(Eq. 1)}$$

4.2 Bread density

Product density was analyzed by replacing sesame seeds, following the AACC method 10–05 (AACC, 2000) and weighing the bread. Density was calculated from the bread weight to bread volume ratio (Eq. 2).

$$\text{Density } (\text{g/cm}^3) = \frac{\text{Bread weight (g)}}{\text{Bread volume } (\text{cm}^3)} \quad \text{(Eq. 2)}$$

The texture of bread was analyzed using texture profile analysis (TPA) according to the method of Huttner & Arendt (2010).

Huttner & Arendt (2010) analyzed the texture of bread using texture profile analysis (TPA). A 100-mm diameter cylindrical probe (P/100) was used. A sample size of 25 × 25 × 25 mm (width × length × height) was cut. The operating conditions of the machine were set to a pre-test speed of 1.00 mm/s, test speed of 1.00 mm/s, post-test speed of 1.00 mm/s and distance of 40% of its original height. Hardness, cohesiveness, gumminess and chewiness were reported.

5. Statistical analysis

A completely randomized design was used in the analysis of variance and Duncan's new multiple range tests. A confidence level of 95% was considered. The statistical analysis program SPSS V. 21 (IBM Corp., Chicago, USA) was used to run the analyses.

Results and discussion

1. The study of yeast morphology

Yeast counts of 1.8×10^4 and 1.3×10^4 colonies were found in sugarcane and apples, respectively. The colonies that grew on the solid surface were round, convex and had a smooth surface, smooth edges, opaque white color and elliptical shape with unilateral arrangement (Fig. 1). This unilateral arrangement was predominantly observed in yeast strains *S. cerevisiae* and consistent with the results obtained by Salem et al. (2016), which showed that yeast cells could be seen under a 40 magnification microscope. However, in addition to *S. cerevisiae*, other microorganisms that contaminate with the fruits during fermentation may also be presented.

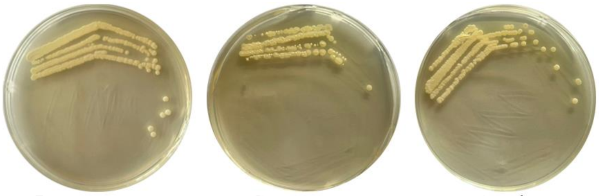

Fig. 1 Yeast colonies (left to right: instant yeast, sugarcane yeast and apple yeast)

2. Sugar utilization of various fruit yeasts

Fermentation happens naturally in any sugar-containing mash made from fruits. When exposed to a warm environment, airborne yeasts converts sugar into carbon dioxide and ethyl alcohol (Saranraj et al., 2017). The amount of yeast from different fruits are shown in Table 1. Instant yeast had the highest significant reduction in TSS (°Brix), followed by sugarcane and apple, which decreased by 50.85% and 34.5%, respectively. The TSS of instant yeast was reduced by 79% on the third day, indicating that sugarcane could produce more yeast than apples. On days 1–3, instant yeast, sugarcane and apple showed significantly different decreases in TSS ($p \leq 0.05$). This was because yeast uses sugar as an energy source. Sugar can be converted into carbon dioxide and ethyl alcohol during fermentation. However, from day three onwards, there was no statistically significant decrease in TSS ($p > 0.05$) since the three fruit yeast types began to convert to alcohol on day four. This was observed as foaming on the surface of the yeast solution. However, fruits can generate less yeast than instant yeast because the latter is purer compared to fruit yeast, which is an injured cell. Therefore, it uses less sugar than instant yeast.

Table 1 Utilization of yeast sugar from three different sources

Day	Total soluble solid (°Brix)		
	Instant yeast	Sugarcane yeast	Apple yeast
1	12.40 ± 0.40^{aC}	15.57 ± 0.25^{bC}	18.40 ± 0.20^{cC}
2	8.10 ± 0.20^{aB}	11.57 ± 0.40^{bB}	15.47 ± 0.25^{cB}
3	4.16 ± 0.15^{aA}	9.83 ± 0.30^{bA}	13.10 ± 0.30^{cA}
4	3.90 ± 0.30^{aA}	9.10 ± 0.20^{bA}	12.70 ± 0.40^{cA}
5	3.20 ± 0.40^{aA}	8.95 ± 0.45^{bA}	12.14 ± 0.20^{cA}

Remark: Superscripts in English letters (A–C) in the same column indicate a significant difference ($p \leq 0.05$)
Superscript in English letters (a–c) in the same row indicates a significant difference ($p \leq 0.05$)

3. Study of the physical properties of bread

The results are shown in Fig. 2, Tables 2 and 3. It was found that fruit yeast reduced the bread volume and as a result the specific volume of bread. Density increased ($p \leq 0.05$) compared to instant yeast bread because fruit produces less yeast compared to instant yeast (Table 1).

Fig. 2 Sweet bread produced using different yeasts (left to right: instant yeast, sugarcane yeast and apple yeast)

Table 2 Physical properties of sweet bread made from fruit yeasts

Physical Properties	Type of yeast		
	Instant yeast	Sugarcane yeast	Apple yeast
Volume (cm^3)	394.33 ± 4.04^{a}	336.66 ± 3.21^{b}	274.33 ± 3.05^{c}
Specific volume (cm^3/g)	4.85 ± 0.07^{a}	4.27 ± 0.03^{b}	3.53 ± 0.02^{c}
Density (g/cm^3)	0.21 ± 0.03^{c}	0.25 ± 0.03^{b}	0.29 ± 0.04^{a}

Remark: Superscripts in English letters (a–c) in the same row indicate a statistically significant difference ($p \leq 0.05$)

In baked goods, yeasts are responsible for raising the product through fermentation. Sugar is used as an energy source and carbon dioxide is produced in the process. Air expands at higher temperatures during fermentation. The gluten from kneading the mixture expands and stretches to envelop those gases, thus making the product rise. When heated in an oven, yeast stops working and the resulting alcohol evaporates during baking (Gisslen, 2016). However, if there is insufficient yeast, the bread will not increase as it should. Using fruit yeasts as a substitute for all instant yeasts in sweet bread products reduces breads volume and as a result the specific volume. The volume and specific volume of bread made with instant yeast, sugarcane yeast and apple yeast were 394.33/4.85, 336.66/4.27 and 274.33/3.53, respectively. This is because fruit yeasts are injured cells. Fermentation efficiency is reduced and the ability to use sugar decreases. As a result, the ability to generate carbon dioxide is reduced accordingly and bread will rise less. Apple yeasts had the lowest specific volume due to insufficient yeast production during bread production. When used in bread production, the yeast was less capable of emitting carbon dioxide, reducing the rise in bread. Due to small air cavities, the bread was very dense after baking.

Bread density is inversely related to volume and specific volume. The density of a bread increases when its volume and specific volume are reduced. The bread made with apple yeasts was the densest, corresponding to a more significant hardness, gumminess and chewiness that were directly related to each other. Thus, when the hardness and gumminess of bread increased significantly ($p \leq 0.05$), it was harder to chew.

Different types of yeast resulted in different amounts of yeast and varying bread quality. It decreased the bread volume and specific volume but increased the density, affecting the texture profile in terms of increasing hardness, gumminess and chewiness (Table 3). This corresponds to decreased texture profile test scores.

Table 3 Texture profiles of fruit yeast bread

Texture	Type of yeast		
	Instant yeast	Sugarcane yeast	Apple yeast
Hardness (N)	66.95 ± 2.43^a	76.87 ± 6.73^b	143.57 ± 1.77^c
Springiness ^{ns}	0.69 ± 0.23	0.79 ± 0.28	0.88 ± 0.01
Cohesiveness	0.71 ± 0.01^a	0.75 ± 0.06^b	0.80 ± 0.02^c
Gumminess	44.04 ± 0.75^a	60.57 ± 1.62^b	103.33 ± 2.40^c
Chewiness	37.2 ± 1.88^a	40.32 ± 17.22^b	90.83 ± 2.47^c

Remark: Superscripts in English letters (a–c) in the same row indicate a significant difference ($p \leq 0.05$)
ns means that there was no significant difference ($p > 0.05$)

Conclusion

This study examined fruit yeasts as a substitute for instant yeasts in sweet bread products by comparing sugarcane yeast and apple yeast with instant yeast as a control recipe. Sugarcane yeasts produced significantly more yeast than apple yeast ($p \leq 0.05$) based on the amount of TSS reduced. The bread made with sugarcane and apple yeasts had less bread volume and specific volume, but was denser compared with bread from instant yeast. This was due to fermented fruit yeasts cannot make the bread rise as much as instant yeasts. Consequently, the bread produced from sugarcane and apple yeasts was dense, gummy and chewy. However, the study of microscopy and biochemistry should be performed in the future.

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