

The Preparation and Storage Time of Red Ginger (*Zingiber officinale* var. *Rubrum*)-supplemented Bread

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ABSTRACT

Discovering new variants of healthy bread is always a challenge. This work aimed to prepare red ginger supplemented-bread and to study its storage time. Red ginger was chosen as the supplement due to its high content of phenolic compounds, which are well-known for their antioxidant activity. Various concentrations (3%, 4.5%, and 6%) of fresh and powdered-red ginger were supplemented into bread materials. The mixtures were developed at 37 °C for 45 minutes and baked at 190 °C for 10 minutes. The storage times of fresh- and powdered-red ginger supplemented were 9-11.67 and 6.33-8.33 days, respectively, indicating longer storage time of red ginger supplemented-bread than the control one (mould grew on the 5th day). Moreover, a hedonic test (based on the odor, taste, and texture preferences) showed that the 3% red ginger supplemented-bread was more preferred by panelists (n=30). Red ginger supplemented-bread may have the potential for a new variant of healthy bread; however, further study on its antioxidant activity is still needed.

Keywords: antioxidant, gingerol, phenolic compounds, red ginger bread, *Zingiber officinale*.

Introduction

Discovering new variants of healthy and tasty bread is always a challenge. To improve its taste, color, and aroma, some process including fortification could be done by adding spices, with additional benefits such as function on preservatives, antioxidants, antimicrobials, etc. Industry and research are involved in optimizing bread-making technology to improve the variety, quality, taste, and availability of food product.^[1,2] Plant extracts and their essential oils have been proven to possess the potential as antimicrobials.^[3-5] Spices and herbs have also been reported to be strong antioxidants due to their phenolic acids, terpenes, aldehydes, and flavonoids contents.^[6] Food products that contain antioxidants are often utilized to maintain health due

to the free radicals scavenging activity of the flavonoids and their inhibitory effect against oxidative reactions.^[2,7,8]

Red ginger (*Zingiber officinale* var. *Rubrum*), which has a spicy and warm taste, is often used as a food additive. It contains gingerol, oleoresin, limonene, α -linoleic acid, aspartic, β -sitosterol, and starch elements such as starch, caprylic acid, capsaicin, chlorogenic acid, and farnesyl.^[9] Phytochemical screening showed that flavonoid, quinone, and monoterpenoid/sesquiterpenoid were detected in both dried rhizome and water extract of red ginger. The water extract inhibited the rate of prostaglandin production, which supported its anti-inflammatory activity.^[10] Another study reported that in the plasma of the healthy participants subjected to a single dose of red ginger oral suspension, 10-gingerol and 6-shogaol were absorbed and quantified. These red ginger analytes exhibited relatively slow elimination half-lives.^[11] The selection of a proper method of red ginger processing, which includes washing, slicing, and drying methods and temperatures were necessary for maintaining the chemical compounds in red ginger, consequently, the benefits of red ginger can be obtained optimally.^[12]

The use of ginger (*Zingiber officinale* Roscoe) powder in bread has been reported as a functional ingredient,^[13] however, the use of red ginger (*Z. officinale* var. *Rubrum*) in bread is still limited or

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unavailable. Our work was conducted to study the influence of red ginger powder supplemented in bread and its effect on the storage time.

Materials and Methods

Plant materials

5 kg of *Z. officinale* var. *Rubrum* plant was purchased from Research Institute for Spices and Medicinal Plants (Balitro) Manoko Lembang, West Java, Indonesia (<http://balitro.litbang.pertanian.go.id/?p=993&lang=en>).

The plant was taxonomically identified by Joko Kusmoro, a certified biologist at the Laboratory of Plant Taxonomy, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran, Indonesia (Letter No. 155/HB/09/2018).

Red ginger powder preparation

4 kg of fresh red ginger rhizomes were washed under running water for 1 minute and were dried in the open air for 24 hours. The dried rhizomes were peeled-off and then cut with 0.30 cm thickness using a slicer machine (Ellane VC 60 MP). The thin slices of red ginger rhizomes were arranged in a container covered with a black cloth and were sundried for 6.33 hours (380 minutes). The dried red ginger slices were powdered using a grinding machine (Vitamax MPS 2015) and sifted using a 200-mesh sieve. The powder yield was 110 g (11%).

Bread preparation

The formula of the red ginger supplemented-bread is provided in Table 1. The mixture was developed at 37°C for 45 minutes (Mahyih MYC 18) and baked at 190 °C for 10 minutes (Mahyih MY-339). The bread was allowed to cool at room temperature and each bread was packed into a single sealed-plastic pouch. The bread was evaluated for its (1) proximate analysis, (2) storage time, and (3) hedonic test.

Proximate analysis

Proximate analysis was performed on the red ginger powder and the red ginger supplemented-bread as per required by the Indonesian National Standard (SNI-01-2891-1992).

Storage time observation

The red ginger supplemented-bread was daily observed during its 14-day storage, particularly on the growth of mold.

Hedonic test

a Likert scale on 30 panelists. Samples were randomly assigned to the panelists. The panelists were asked to evaluate each parameter used which were (1) odor/flavor, (2) taste; (3) texture, and (4) sweetness of the bread. The five-point hedonic scale was represented as 5 = strongly agree, 4 = agree, 3 = ordinary, 2 = disagree, and 1 = strongly disagree.

Result and Discussion

Proximate The result of the proximate analysis is provided in Table 2.

Proximate analysis of red ginger powder indicated that protein (3.37%), carbohydrate (11.90%), anthocyanin (21.68%), and vitamin C (68.26%) were contained in the powder. Moreover, protein (8.18%), carbohydrate (67.05%), and fat (8.86%) were quantified in the bread. Comparison of our result with that of the previous studies indicated a positive similarity. Ginger root (*Z. officinale*) contains vitamin C (9.33 mg/100 g),^[14] whereas two types of anthocyanin (cyanidin 3-glucoside and peonidin 3-rutinoside) had been isolated from Japanese ginger rhizomes.^[15] Furthermore, the proximate analysis of fresh ginger rhizome showed mostly carbohydrates (71.46%) and crude protein (8.83%).^[16]

Storage time observation

The storage time of the red-ginger bread was evaluated by observing particularly on the growth of mold (Figure 1). The control bread (contained 0% red ginger powder) was used for comparison (Table 3). The result showed that bread supplemented with fresh red ginger and powdered-red ginger possessed longer storage time, which were 9-11.67 and 6.33-8.33 days, respectively. The antioxidant agents (phenolic compounds e.g. gingerol, shogaol, etc.) in red ginger are predicted to play a role in inhibiting the mold growth.

These phenolic compounds, contained in ginger, had been reported to possess inhibitory activity against the oxidative reactions.^[2, 7, 14, 17, 18] A previous study reported that essential oils-coated food significantly inhibited the growth of psychrophilic aerobes, yeasts, and molds. Essential oils showed antimicrobial effect against *L. innocua* inoculated into apple pieces. β -cyclodextrin encapsulated onto garlic oil was reported to inhibit the microbial growth of fresh-cut tomato.^[19] Our findings indicated that red ginger can prolong the storage time of bread, however, the effect of its active compound on inhibiting mold growth appears to be reduced by the drying process.

Ginger and turmeric have been reported to inhibit the growth of *Rhizopus stolonifer* on bread and, therefore, these spices have been proposed to be used for the improvement of bread shelf-life.^[20] Ginger compounds were reported to possess a thermolabile property in which degradation was observed at moderate temperature.^[21]

Hedonic test

Descriptive results of the Hedonic test questionnaires are shown in Table 4. Furthermore, the average score of preferences is summarized in Table 5, which indicated that red ginger supplemented-bread 4 (contains 3% of red ginger powder) was the most preferable bread, however, its sweetness should be increased to improve its taste.

We compared our result with that of Balestra and colleagues (2011).^[13] They evaluated the antioxidant, rheological, and sensorial properties of wheat flour dough and bread containing ginger powder and reported that the highest total phenolic compound and radical scavenging activity were achieved in the bread containing 6% ginger powder, regardless that the dough and the bread had a tough structure. Bread with 3% ginger

powder showed good rheological characteristics and the highest sensorial acceptability.^[13]

Bread is a generally-accepted food, which can be taken as a convenient food for plant-based nutrient fortification to improve health. Our red ginger supplemented-bread might be potential for a new variant of healthy bread, however, further study on its antioxidant activity as well as its effect on the lipid profile of participants are still needed.

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Table 1. Formulation of 1000 g of red ginger-supplemented bread

Ingredient	Formula 1 of red ginger-supplemented bread	Formula 2 of red ginger-supplemented bread	Formula 3 of red ginger-supplemented bread
Margarine (g)	130.0	130.0	130.0
Butter (g)	50.0	50.0	50.0
Sugar (g)	200.0	200.0	200.0
NaHCO ₃ (tsp)	3.0	3.0	3.0
Eggs	4.0	4.0	4.0
Salt (tsp)	0.5	0.5	0.5
Sweet condensed-milk (g)	40.0	40.0	40.0
Yeast (g)	50.0	50.0	50.0
Fresh/powdered ginger (g)	30.0	45.0	60.0
Water (ml)	200.0	200.0	200.0
High protein flour	qs	qs	qs

Control bread were made without the addition of red ginger (0 %).

Table 2. Proximate analysis (Indonesian National Standard SNI-01-2891-1992)

No.	Parameter of analysis	Red ginger extract	Red ginger-supplemented bread	Method
		Document No. 601/lab.uji-DT/FTIP/SF/2018	Document No. 235/lab.uji-DT/FTIP/SF/2019	
1	Water (%)	81.67	23.18	
2	Ash (%)	1.34	0.73	
3	Protein (%)	3.37	8.18	
4	Fat (%)	1.72	8.86	
5	Carbohydrate (%)	11.90	67.05	
6	Calorie (kcal)	76.56	Not measured	
7	Anthocyanin (mg/l)	21.68	Not measured	pH Differential
8	Vitamin C (mg/100 g)	68.26	Not measured	Titrimetric

Table 3. Observation on the growth of mould on the bread (n = 3)

Variation of red ginger concentration of bread	Mould appear (days)
Control bread (red ginger 0%)	5.00
Red ginger bread 1 (fresh ginger 3%)	9.00
Red ginger bread 2 (fresh ginger 4.5%)	10.33
Red ginger bread 3 (fresh ginger 6%)	11.67
Red ginger bread 4 (red ginger powder 3%)	6.33
Red ginger bread 5 (red ginger powder 4.5%)	7.33
Red ginger bread 6 (red ginger powder 6%)	8.33

Table 4. Hedonic test (n=30)

Parameter	Preference	Red ginger bread 4 (contained 3% of red ginger powder)	Red ginger bread 5 (contained 4.5% of red ginger powder)	Red ginger bread 6 (contained 6% of red ginger powder)
Preference for the odour/flavour of the red ginger bread (%)	Strongly agree	40 %	10 %	33 %
	Agree	43 %	33 %	17 %
	Ordinary	17 %	40 %	33 %
	Disagree	0 %	10 %	13 %

	Strongly disagree	0 %	7 %	3 %
	Strongly agree	40 %	30 %	57 %
	Agree	37 %	43 %	23 %
Preference for the taste of the red ginger bread (%)	Ordinary	20 %	17 %	10 %
	Disagree	3 %	10 %	7 %
	Strongly disagree	0 %	0 %	3 %
	Strongly agree	30 %	33 %	27 %
	Agree	57 %	40 %	40 %
Preference for the texture of the red ginger bread (%)	Ordinary	10 %	27 %	33 %
	Disagree	3 %	0 %	0 %
	Strongly disagree	0 %	0 %	0 %
	Strongly agree	7 %	10 %	3 %
	Agree	23 %	20 %	30 %
Preference for the sweetness of the red ginger bread (%)	Ordinary	57 %	50 %	40 %
	Disagree	10 %	17 %	13 %
	Strongly disagree	3 %	3 %	13 %

Table 5. Summary of Hedonic test

Parameter	Red ginger bread 4 (contained 3% of red ginger powder)	Red ginger bread 5 (contained 4.5% of red ginger powder)	Red ginger bread 6 (contained 6% of red ginger powder)
Preference for odour/flavour	84.67 %	66.00 %	72.67 %
Preference for taste	82.67 %	78.67 %	84.67 %
Preference for texture	82.67 %	81.33 %	78.67 %
Preference for sweetness	64.00 %	63.33 %	59.33 %
Average of preference	78.50 %	72.33 %	73.83 %



Figure 1. Mould (red arrow) was observed on the surface of the bread (contained 3% of fresh red ginger) at day-9