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# Quality of wheat bread incorporated with different levels of peach palm flour (*Bactris gasipaes* Kunth)

(Kualiti roti gandum yang diadun dengan pelbagai tahap tepung *Bactris gasipaes* Kunth)

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Keywords: composite flour, peach palm, nutritional value, dough rheology, bread quality

**Abstract**

Different levels (5, 10, 15, 20 and 25%) of peach palm flour were incorporated into wheat flour and their effects on the quality of bread were investigated. Data showed that the nutritional value of wheat flour, in terms of fibre and total carotenoids, improved significantly with the addition of peach palm flour. Rheological measurements, using farinograph and amilograph instruments, showed that the addition of peach palm flour increased the water absorption capacity of the flour mixture up to 12% but decreased the other rheological characteristics. The gelatinization temperature and the temperature at the end of gelatinization increased up to 3 and 14.5 °C respectively, but the viscosity decreased. The bread volume increased between 250–600 ml with the addition of peach palm flour. Textural properties of the bread indicated that the compression force increased between 63–523, 133–1030 and 160–726 g force and the shear force decreased between 26–873, 232–908 and 243–1066 g force on first, second and third day of storage respectively, with increasing levels of peach palm flour. Sensory analysis of the bread showed an improvement in the overall quality of the composite flour. Incorporation of peach palm flour further retards the staling rate of bread. Among the samples, panellists preferred the bread incorporated with l0% and 15% peach palm flour.

## Introduction

The use of non-wheat flour in bread products is creating great interest because some of these grains have important health benefits. Peach palm, pupunha and pejibaye are the three given names for the same fruit, grown in tropical areas, which may be suitable for incorporation into bread products both in terms of its physico-chemical properties as well as its nutritional advantage. Bakery products are becoming progressively popular due to their ready-to-eat convenience, price competitiveness, and accessibility of a choice of products with

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different feel and textural profiles, nutritious and have a longer shelf life. Other socio-economic factors such as increased revenue, the need to save time and ready access to the shelf at any time are also liable for the growing demand of bakery products. Bread is predominant of all the bakery goods available in the markets.

It has been reported that in Brazil, a number of wheat flour-based mixtures blended with cassava, soy, rice and corn flour has been used for making different kinds of food stuffs because of their suitability in terms of physicochemical properties as well as nutritional advantage (Vitti et al. 1979). Peach palm flour blended with wheat flour has been used by the Amerindians of the Amazonas for bread production (Clement 1987; Clement et al. 1993). In terms of nutritional value, the peach palm flour has a high content of beta-carotene, minerals, essential amino acids and oil which may increase the nutritional value of the resulting end-products (Piedrahita 1987; Yuyama et al. 1991; Yuyama and Cozzolino 1996; Leterme et al. 2005). Tracy (1987) produced bread containing 10% peach palm flour with agreeable results from both technological and nutritional point of view. Oliveira et al. (2006) integrated 15% of peach palm flour into wheat flour and studied some aspects of the rheological properties and pasta making possibilities of the mixed flour.

The chemical composition of peach palm flour has been investigated by a few researchers (Gomes and Amelotti 1983; Monteiro et al. 2002; Yuyama et al. 2003). The average nutritional composition of peach palm flour is 8.1% moisture, 1.3% ash, 6.8% protein, 12.6% lipid, 6.7% fibre, 64.5% carbohydrate and 9.8% total carotenoids.

A literature search indicated that no work has been carried out investigating the effects of peach palm flour on dough rheological properties and the quality of bread produced with composite flours made from peach palm and wheat flours. Hence, this study was carried out to determine the effect of peach palm flour (*Bactris gasipaes* Kunth) on the nutritional, chemical, physical and sensorial characteristics of wheat flour, dough and bread.

## Materials and methods

### *Materials*

Peach palm fruit, wheat flour, sugar, salt, fat, yeast and milk powder were all obtained from the local market. All of the other chemicals, reagents and solvents used in the study were of analytical grade and obtained from Merck (Darmstadt, Germany) and Sigma (MO, USA). Distilled water was used in all of the experiments throughout the study.

### *Preparation of peach palm flour*

The fruit was removed from the cluster, washed and cooked in boiled water for about l0 min. After cooling, the seeds of the fruit were removed and the fruit pulp was ground, placed on trays and dried in an oven at 65 °C for about 1 h. After drying, the dried pulp was milled to a fine flour using a laboratory mill (Alpine, Augsburg, Germany). The particle size of the flour was fixed by sieving with a Ro-tap shaker, using standard sieve apertures, till 93% of the peach palm flour particles were about 250 μm.

### *Experimental treatments*

The peach palm flour was incorporated into wheat flour at different levels (5, 10, 15, 20 and 25%). The chemical composition of the wheat flour and the composite flours was determined. The rheological characteristic of the dough, prepared from wheat flour and mixed flours, was measured using the frarinograph and amilograph. Bread was made from wheat flour and composite flours for evaluation of quality characteristics.

### *Chemical composition of flour*

The moisture, ash, nitrogen and fibre content were determined using AACC (1995) methods 44–16A, 08–01, 46–13 and

32–10 respectively. Nitrogen was converted into total protein using a factor of 5.7. Lipids were quantified, using the Soxhlet method 30–10 (AACC 1995). Carbohydrate content was determined by subtracting the percentage of protein, lipids, fibre and ash from l00. Total carotenoids were measured according to the procedure described by Higby (1962).

***Rheological characteristics of dough***

Dough properties were studied using farinograph and amylograph instruments (Brabender, Druisburg, Germany), based on AACC (1995) methods 54–21 and 22–10. From the farinograph curve some characteristics such as water absorption, dough development time, dough stability, mixing tolerance index and valorimeter value of the flour-water dough can be determined. On the other hand, temperatures at the beginning of the process, at the beginning and end of gelatinization, and amylograph viscosity can be defined from the amylograph curve.

***Bread making and sensory analysis***

Breads were prepared from wheat flour and composite flours (containing 5, 10, 15, 20 and 25% peach palm flour), according to the procedure of Irvine and McMullan (1960). The basic recipe was as follows: Peach palm flour + wheat flour 100 g (5 + 95, 10 + 90, 15 + 85, 20 + 80 and 25 + 75), sugar 2 g, salt 1 g, fat 2 g, yeast 2 g, milk powder 2 g and water as indicated by the farinograph water absorption capacity. Dough was prepared using the straight dough method. Specifications of bread baking conditions were: dough loaf weight 500 g, first fermentation time 90 min, second fermentation time 15 min, proofing time 45 min, baking temperature 400–450 °C and baking time 25 min. After baking, breads were cooled, packed in polypropylene bags and evaluated after 24, 48 and 72h, by 15 experienced panellists, following the procedure described in Standard Methoden Fur (fur Get 1978).

In this evaluation quality characteristics such as crumb colour, taste, odour, appearance, consistency and the overall quality of the breads were evaluated and scores were given for each evaluation from 0 to 5, with 5 being the highest value. The volume of the bread was measured by the rapeseed displacement method (Malloch and Cook 1930). The staling rate of breads was evaluated using method 74–30 (AACC 1995).

***Measurement of bread texture***

The bread firmness, in terms of force (g) required for 25% compression of a 20 mm thick bread slice, was measured using a Texture Analyzer TA-XT2 (Stable Micro Systems-SMS, Surrey, England), using a load cell of 5 kg. Software Texture Expert, version 06–11, was used in the data analyzer. An aluminum plunger of 40 mm diameter was used and the crosshead and return speed was adjusted to 2 and 5 mm/s respectively. The shear test was also applied to the bread slice using the HDP/BSW device at the same condition except for a running distance of 30 mm for cutting (AACC 1995).

***Statistical analysis***

All the values reported are means of triplicate readings. The data were statistically analysed using analysis of variance in completely randomized design (CRD). Duncan multiple range test was used as the test of significance to separate the means at $p < 0.05$ (Steel and Torrie 1980). The analysis was conducted using SPSS software (Kinnear and Gray 1999).

***Identification codes***

The codes used to identify the samples are as follows: (PF) peach palm flour, (WF) wheat flour, mixture of 5, 10, 15, 20 and 25% peach palm flour and 95, 90, 85, 80 and 75% wheat flour (WP 5, WP 10, WP 15, WP 20 and WP 25) respectively.

## Results and discussion

### *Chemical composition of flour*

*Table 1* shows the chemical composition of the wheat flour (WF), peach palm flour (PF) and composite flour (WP) samples. Comparison between WF and WP indicated that the addition of 5–25% PF caused a reduction in the moisture up to 1%, protein up to 4% and the carbohydrate content up to 2% in WP flours. These reductions were caused by the lower moisture, protein and carbohydrate content of PF flour. However, the amount of ash, lipids, fibre and total carotenoids increased up to 0.5, 3.8, 1.3 and 2.5% respectively. The amount of these nutrients increased because higher amounts were found in the PF flour. A higher level of fibre and carotenoids is very important, from the nutritional point of view.

As shown in *Table 1*, changes in the nutrient contents of WP flours were affected by the incorporation of the PF flours. This was similar to work conducted by Ade-Omowaye et al. (2008) on varying proportions (100:0; 90:10; 80:20; 70:30; 60:40; 50:50) of tigernut-wheat composite flour proximate composition and physico-chemical properties. The protein content (%) of the composite flour decreased with increasing amount of tigernut flour substitution due to the low protein content of the tigernut flour. There was a notable enhancement of fibre content, an improvement in the ash content and an increase in the fat content (%) of the composite flour due to the presence of high fibre, ash and fat content in the tigernut flour. The carbohydrate content (%) of the composite flour decreased, indicating a low carbohydrate content in the tigernut flour.

### *Rheological characteristics of dough*

The farinograph characteristics of wheat flour and mixed flour are presented in *Table 2*. The water absorption increased up to 12% when PF was added to the wheat flour. Dough development time was not significantly different with the addition of different levels of PF (up to 20%). Valorimeter value did not show any specific trends. In general, incorporation of PF gave the maximum improvement in the water absorption capacity of the mixed flours (WP) but has opposite effect on the other dough properties.

The water absorption capacity of the flour in the farinograph test is defined as the amount of water necessary to centre the farinogram curve on the 500 Brabender unit line for the flour-water dough. The increase in the water absorption capacity of the composite flour may be attributed to the higher fibre and carbohydrate contents with increasing amounts of peach palm flour substitution (*Table 1*). The ability of flour to absorb water has a significant correlation with its carbohydrate content. Dough stability decreased, up to 1.5 min, by increasing the amount of PF in WF. Mixing tolerance index, at 10 and 20 min, increased by 40 with the addition of PF, showing the weakness of mixed flours.

Table 1. Chemical composition of wheat, peach palm and mixed flours

| Sample | Moisture (%) | Ash (%) | Protein Nx5.7 (%) | Lipid (%) | Fibre (%) | Carbohydrate (%) | Total carotenoids (mg%) |
|---|---|---|---|---|---|---|---|
| WF | 11.15e | 0.75a | 12.3g | 1.06a | 1.41a | 73.4g | – |
| PF | 8.14a | 1.32d | 6.8a | 12.6g | 6.7g | 64.5a | 9.79f |
| WP 5% | 10.98d | 1.16cd | 12.02f | 1.72f | 1.69b | 72.93f | 0.51a |
| WP 10% | 10.76cd | 1.18c | 11.54e | 2.36e | 2.07c | 72.56e | 0.98b |
| WP 15% | 10.63c | 1.20bc | 10.83d | 2.52d | 2.34d | 72.14d | 1.49c |
| WP 20% | 10.55bc | 1.25b | 9.67c | 3.74c | 2.67e | 71.86c | 1.96d |
| WP 25% | 10.41b | 1.29b | 8.18b | 4.85b | 2.75f | 71.13b | 2.48e |

WF = Wheat flour, PF = Peach palm flour, WP = Mixed flour
Values in the same column followed by a different letter differ significantly ($p < 0.05$)

Table 2. Farinograph characteristics of dough of wheat and mixed flours

| Sample | Water absorption (%) | Dough development time (min) | Dough stability (min) | Mixing tolerance index at 10 min (BU) | Mixing tolerance index at 20 min (BU) | Valorimeter value (BU) |
|---|---|---|---|---|---|---|
| WF | 63a | 2.5a | 2.5c | 80a | 170a | 46ab |
| WP 5% | 66b | 3.5c | 3.0d | 90b | 180b | 47b |
| WP 10% | 69c | 3.7cd | 2.5c | 100c | 190c | 48bc |
| WP 15% | 71d | 3.5c | 2.0b | 100c | 200d | 46ab |
| WP 20% | 74e | 3.2bc | 1.5a | 110d | 210e | 47b |
| WP 25% | 75e | 3.0b | 1.5a | 120e | 210e | 45a |

WF = Wheat flour, WP = Mixed flour
Values in the same column followed by a different letter differ significantly ($p$ <0.05)

Table 3. Amylograph characteristics of wheat and mixed flours

| Sample | Temp at beginning of process (°C) | Gelatinization temp (°C) | Temp at end of gelatinization (°C) | Amylograph viscosity (BU) |
|---|---|---|---|---|
| WF | 24.6c | 52.7bc | 68.9a | 1000f |
| WP 5% | 24.4bc | 52.4b | 75.8b | 990e |
| WP 10% | 24.2b | 52.5b | 76.9c | 940d |
| WP 15% | 23.8a | 51.8a | 79.3d | 905c |
| WP 20% | 24.3b | 54.3c | 82.8e | 820b |
| WP 25% | 23.9a | 55.6d | 83.4f | 800a |

WF = Wheat flour, WP = Mixed flour
Values in the same column followed by a different letter differ significantly ($p$ <0.05)

The dough stability is a value that indicates the tolerance of the flour to the mixing and is defined as the difference in time, to the nearest half minute, between the point where the top of the curve first intercepts the 500 BU line and the point where the top of the curve leaves the 500 BU line (*Figure 1*). Flours which have a low tolerance to mixing, exhibit high mixing tolerance indices. This means that adding PF to the WF results in a weaker flour. There are no studies about the farinogram properties using PF in composite flours used in food products such as bread. However, this result is in concordance with Oliveira et al. (2006), where 15% peach palm flour was incorporated into wheat flour and the mixed flour was tested in a farinograph. They reported an increase in water absorption and dough development time but a reduction in stability, departure time and tolerance index.

*Table 3* shows the amylograph characteristics of WF and WP samples.

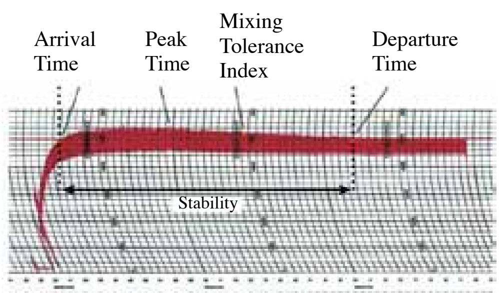


*Figure 1. A sample curve for strong gluten flour (Anon. 2008)*

As shown, the gelatinization temperature increased from 52.7 to 55.6 °C by increasing the amount of peach palm flour. At the end of gelatinization, the temperature increased by 14.5 °C, with incorporation of 25% PF into WF. However, the addition of peach palm flour decreased the amylograph viscosity by 200 BU units. There are no studies about amylograph properties using PF in composite flours. However, some researchers have used the amylograph method to evaluate composite flours. Hugo et al. (2003) integrated 30% fermented sorghum flour to wheat flour and reported, not a decrease for pasting temperature, but a slight increase in peak and final viscosity.

***Bread quality***

Data on the loaf volume and specific volume of the bread, as influenced by different levels of peach palm flour, are presented in *Table 4*. There was a significant improvement in the volume and specific volume of the bread, with the addition of peach palm flour. The improvement in the volume of the breads, with different levels of PF, was 250–600 ml. The maximum improvement in the volume and specific volume of bread was obtained with PF 15% (*Table 4*). However, the improvement in the bread volume reduced as the PF content increased above 15%. In general, the data showed that maximum improvement in the volume and specific volume of bread was obtained with PF 15, followed by PF 20, 25, 10 and 5 respectively.

Higher loaf volume and weight have an encouraging economic effect on bread at the retail shop, as consumers often get attracted to a bread loaf with higher weight and volume believing that it has more substance for the same price. Loaf volume is affected by the quantity and quality of protein in the flour (Ragaee and Abdel-Aal 2006). Hugo et al. (2003) integrated 30% fermented sorghum flour to wheat flour and reported an increase in the bread volume and a slight increase in the weight and the moisture content of the breads. The increase in volume of bread made with WP flour can be attributed to an improvement of the gas-holding capacity of the composite dough, caused by the increased viscosity of the mixed flour (*Table 3*). An increase in dough viscosity results in an improvement of the gas-holding capacity of the wheat dough, resulting in a higher volume (Gan et al. 1995).

Table 4. Bread characteristics

| Sample | Loaf weight (g) | Loaf volume (ml) | Specific volume V/W (ml/g) |
|---|---|---|---|
| WF | 420a | 1500a | 3.57a |
| WP 5% | 420a | 1750b | 4.17b |
| WP 10% | 430b | 1950c | 4.54c |
| WP 15% | 435bc | 2100e | 4.83d |
| WP 20% | 440c | 2050d | 4.66cd |
| WP 25% | 440c | 2000d | 4.55c |

WF = Wheat flour, WP =Mixed flour
Values in the same column followed by a different letter differ significantly ($p < 0.05$)

Table 5. Texture of bread during three days storage

| Sample | Days of storage | Compression (g force) | Shear (g force) |
|---|---|---|---|
| WF | 1 | 331a | 3168r |
| | 2 | 650e | 2517m |
| | 3 | 1034j | 2124i |
| WP 5% | 1 | 394b | 3142q |
| | 2 | 783g | 2275k |
| | 3 | 1194l | 1881h |
| WP 10% | 1 | 457c | 2976p |
| | 2 | 924i | 2138j |
| | 3 | 1215m | 1778f |
| WP 15% | 1 | 482d | 2756o |
| | 2 | 1122k | 1850g |
| | 3 | 1316o | 1483c |
| WP 20% | 1 | 695f | 2530n |
| | 2 | 1249n | 1746e |
| | 3 | 1616p | 1270b |
| WP 25% | 1 | 854h | 2495l |
| | 2 | 1680q | 1609d |
| | 3 | 1760r | 1058a |

WF = Wheat flour, WP=Mixed flour
Values in the same column followed by a different letter differ significantly ($p < 0.05$)

***Bread texture***

Textural results of the bread with different levels of peach palm flour are presented in *Table 5*. The firmness of the bread was measured using a Texture Analyzer. The data shows the force needed for compression of the bread slices as well as the shear force required for cutting the bread. The lower the value in g force for compressing the slices, the softer the bread. The softness of the bread reduced with addition of PF. The softness value increased by 63–523, 133–1030 and 160–726 g force on first, second and third day of storage respectively.

The results of the study showed that the addition of 5 to 25% peach palm flour further increased the texture value and reduced the softness of bread significantly. In contrast to firmness, the shear force value for cutting the bread decreased by 26−873, 232−908 and 243−1066 g force on the first, second and third day of storage respectively. These can be related to the recrystallization of the starch molecules in the crumb during storage which caused a lighter conjunction between starch molecules resulting in easier breaking under cutting force (Ragaee and Abdel-Aal 2006).

Bhattacharya et al. (2002) baked bread with a composite flour of 10, 20, and 30% waxy durum and wheat flour and reported that the firmness was inversely proportional to the level of waxy flour used in the blend. A 20% waxy wheat flour blend was optimal in retarding staling, while producing bread quality comparable with the control. It was further established that bread made with 20% waxy flour gave lower firmness values after 5 days of storage.

***Sensory characteristics***

The sensory analysis of the bread is reported in *Table 6*. Results showed a significant difference for crumb colour, taste, odour, appearance and consistency between different samples on day 1, 2 and 3. Incorporation of PF into WF improves the quality characteristics of breads, by almost 1 score for all the quality characteristics. Regarding the effect of peach palm flour on the staling rate of breads, it can be concluded that the addition of PF delayed the staling rate. Improvement on bread quality characteristics and retardation in the staling rate was more pronounced when 10−15% PF was added.

As shown in *Table 5*, the compression value, in terms of g force, increased on the first, second and third day of storage. The higher the value needed for compressing the crumb, the harder or staler the bread. Eddy et al. (2007) incorporated 10, 20 and 30%

Table 6. Sensory evaluation of bread on day 1, 2 and 3 of storage

| Days of storage | Sample | Crumb colour | Taste | Odour | Appearance | Consistency |
|---|---|---|---|---|---|---|
| 1 | WF | 4.02a | 3.75b | 3.50a | 4.35c | 3.65a |
| | WP 5% | 4.13b | 3.80bc | 3.60b | 4.40cd | 3.80b |
| | WP 10% | 4.36c | 4.26d | 3.55ab | 4.45d | 4.45e |
| | WP 15% | 4.77d | 4.08c | 4.04e | 4.72e | 4.31d |
| | WP 20% | 4.32c | 3.72b | 3.79d | 4.21b | 4.30d |
| | WP 25% | 4.14b | 3.65a | 3.70c | 4.15a | 4.07c |
| 2 | WF | 3.52a | 3.25a | 3.00a | 3.85b | 3.15a |
| | WP 5% | 3.63b | 3.30ab | 3.10b | 3.90bc | 3.30b |
| | WP 10% | 3.86d | 3.22a | 3.05a | 4.22e | 3.81c |
| | WP 15% | 4.27e | 3.58c | 3.54d | 3.95c | 3.90d |
| | WP 20% | 3.82d | 3.76d | 3.29c | 3.71d | 3.80c |
| | WP 25% | 3.74c | 3.40b | 3.12b | 3.65a | 3.77c |
| 3 | WF | 3.02a | 2.75a | 2.54a | 3.35c | 2.65a |
| | WP 5% | 3.13b | 2.80ab | 2.60b | 3.40cd | 2.80b |
| | WP 10% | 3.77e | 2.72a | 3.04d | 3.45d | 3.45d |
| | WP 15% | 3.36d | 3.26d | 2.55a | 3.70e | 3.50de |
| | WP 20% | 3.32d | 3.08c | 2.79c | 3.25b | 3.55e |
| | WP 25% | 3.24c | 2.90b | 2.62b | 3.15a | 3.25c |

WF = Wheat flour, WP = Mixed flour
All scores were from 0 to 5, with 5 being the highest value
Values in the same column followed by a different letter differ significantly ($p$ <0.05)

cassava flour to bread flour and concluded that bread baked from 30% composite flour showed a low means score to all the attributes. There was a tendency for bread baked with 10 and 20% composite flour to be rated higher than the control especially in aroma, colour, flavour and general acceptability.

## Conclusion

Data showed that the nutritional properties of wheat flour (fibre and total carotenoids contents) which is of interest for health benefits and baking quality, and the resulting bread can be improved significantly with the addition of peach palm flour. Incorporation of peach palm flour further retards the staling rate of bread, which is very important from the economical point of view. Sensory evaluation of PF-incorporated breads showed that the breads were better with regards to quality characteristics such as crumb colour, taste, odour, appearance, consistency, volume and shelf life than the control bread.

In general, the data showed there was maximum improvement in the water absorption capacity but an inverse effect on the other farinograph properties of WF by incorporation of PF. The gelatinization temperature and the temperature at the end of gelatinization increased significantly but the viscosity decreased. Further work needs to be done to verify the effect of peach palm flour on nutritional, chemical, physical and sensory characteristics of different types of flour and bread.

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**Abstrak**
Pelbagai tahap (5, 10, 15, 20 dan 25%) tepung *peach palm* telah dicampur dengan tepung gandum dan kesannya terhadap kualiti roti telah dikaji. Data menunjukkan nilai pemakanan tepung gandum meningkat secara signifikan dalam aspek kandungan serat dan jumlah karotenoid apabila ditambah dengan tepung *peach palm*. Ukuran rheologi menggunakan alat *farinograph* dan *amilograph* menunjukkan tambahan tepung *peach palm* meningkatkan kapasiti penyerapan air tepung campuran sehingga 12% tetapi ciri-ciri lain menurun. Suhu penggelatinan dan suhu pada akhir penggelatinan masing-masing meningkat sehingga 3 dan 14.5 °C tetapi nilai kelikatan menurun. Pertambahan tepung *peach palm* meningkatkan isi padu roti 250–600 ml. Ciri-ciri tekstur roti menunjukkan bahawa daya mampatan masing-masing meningkat 63–523, 133–1030 dan 160–726 kuasa g dan daya ricihan masing-masing menurun antara 26–873, 232–908 dan 243–1066 kuasa g pada hari pertama, kedua dan ketiga penyimpanan dengan meningkatnya tahap tepung *peach palm* dalam adunan. Analisis deria roti menunjukkan peningkatan kualiti tepung komposit. Percampuran tepung *peach palm* seterusnya merencatkan kadar basi roti. Ahli panel menyukai roti yang diadun dengan tepung campuran mengandungi 10–15% tepung *peach palm*.

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