# PHYSICOCHEMICAL AND ORGANOLEPTIC EVALUATION OF MUFFIN PARTIALLY SUBSTITUTED WITH ROSELLE CALYCES (*Hibiscus sabdariffa. L*) POWDER

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**ABSTRACT.** *The effect of substitution of wheat flour with 0%, 5%, 10%, 15% and 20% roselle calyces powder (RCP) on the physicochemical and sensory characteristics of muffin was studied. Roselle calyces powder was produced by using spray drying. The physical (weight, loaf volume, specific volume and oven spring) and proximate analysis showed significant difference (p<0.05) between control and muffin substituted with RCP. Increasing the level of substitution from 5% to 20% of RCP significantly (p<0.05) increased the ash and crude fiber content in muffin samples. Sensory evaluation results indicated that muffin with 10% substitution of RCP was rated the most acceptable.*

**KEYWORDS**: muffin, roselle calyces powder, loaf volume, oven spring, crude fibre

## INTRODUCTION

Roselle (*Hibiscus sabdariffia* L.) belongs to the family Malvaceae and is known as asam paya or asam susur in Malaysia, krajeap in Thailand, bissap in Senegal and chin baung in Myanmar (Wong *et al.*, 2002), while in Sudan and Egypt it is known as karkadé (Mohamed *et al.,* 2012). It can be found in most tropical countries such as Malaysia, Indonesia, Thailand and the Philippines (Ismail *et al.,* 2008). Roselle calyx has a combination of a sweet and tart flavour similar to cranberry (Suliman *et al.,* 2011), with high of dietary fiber, vitamins, minerals and bioactive compounds such as organic acids, phytosterols, and polyphenols (Aurelio *et al.,* 2008).

The calyces are rich in anthocyanins, which are responsible for the red colour, while the acidic taste is due to the presence of some organic acids (Cisse *et al.,* 2009). Regular consumption of roselle may reduce nutritional deficiency problems such as night blindness, scurvy and rickets (Babalola *et al.,* 2001; Ashaye and Adeleke, 2009). The other health benefits include diuretic and choloratic properties, intestinal antiseptic and mild laxative actions. It also used in treating heart and nerve disorders, high blood pressure and calcified arteries (Asolkar *et al.,* 1992). Due to the medicinal benefits and the attractive red colour of roselle calyces, it is widely used in beverages, jellies, confectionaries (Suliman *et al.,* 2011), emulsifiers for carbonated drinks and natural food colourants (Duangmal *et al.*, 2004). Despite being a good nutritional source, roselle calyces powder has not yet been utilised as a food ingredient in bakery products, especially in muffin.

Several authors have used roselle calyces powder to enrich the iron content in bread (Hayashi and Seguchi, 1998); as a mineral and fibre supplement in chocolate cake (Almana, 2001); fruit-flavoured roselle drink (Fasoyiro *et al.,* 2005), and spray dried powder of roselle calyces for use as food colourants (Main *et al.,* 1978). Hence, supplementation of roselle calyces powder would improve the nutritional quality of muffin. The aim of this study was to investigate the effects of substituting wheat flour with a different percentage of RCP on chemical composition, physical and sensory attributes.

## MATERIALS AND METHODS

### *Preparation of roselle calyces powder (RCP)*

Roselle flowers were obtained from Rosella Agro Enterprise, School of Sustainable Agriculture, UMS, Sabah. Roselle calyx were cleaned, peeled and soaked in 0.2% (g/ml) sodium metabisulphite. It was then blended (Panasonic, MX-898) with a ratio of one part roselle calyx to two parts water, and later boiled at 100 °C for 10 minutes and then filtered. The drying process was done in a spray dryer (GEA Niro MOBILE MINOR™ '2000') at 150 °C inlet temperature, 90 °C outlet temperature, 11 rpm pump speed and automiser pressure at 3 bar. RCP accumulated in the bucket powder spray dryers were collected and stored in an airtight container for further processing.

### *Preparation of muffin*

Muffin was prepared according to Hui *et al.*(2006) with slight modification. The muffin formulation was prepared with different percentages of RCP, as shown in Table 1.

**Table 1:** Muffin formulation substituted with different percentages of roselle calyces powder (RCP)

| Formulation | Control | 5% RCP | 10% RCP | 15% RCP | 20% RCP |
|---|---|---|---|---|---|
| Self raising flour (g) | 200 | 190 | 180 | 170 | 160 |
| Roselle calyces powder (g) | - | 10 | 20 | 30 | 40 |
| Sugar (g) | | | 120 | | |
| Butter (g) | | | 70 | | |
| Egg (g) | | | 100 | | |
| Milk (g) | | | 130 | | |
| Salt (g) | | | 3 | | |
| Vanilla (g) | | | 2 | | |

The muffin method was used for mixing muffin ingredients. Dry ingredients (self-rising flour, RCP, sugar and salt) were measured and mixed together by hand for 30 seconds while butter was melted in an oven for 1 minute. The egg was whipped in a mixer (Kenwood Major Classic, UK) for 1 min at speed 4. Milk, vanilla essence and melted butter was then added and mixed in for 30 s at speed 7. The batter was then added to the dry mixture and mixed together for 10 s. The batter was then transferred into paper cups until 2/3 full and baked using a Salva Modular oven for 25 minutes at 180 °C.

***Chemical analysis***

Proximate analysis of moisture, crude protein, ash, crude fat and crude fibre contents of muffin were determined according to the AOAC (2000) method. Available carbohydrate was calculated as 100% (% moisture + % ash + % fat + % protein + % crude fibre). All chemical analyses was carried out in duplicate. Caloric values for all samples were determined by calculation. The percentage for protein, crude fat and carbohydrate were multiplied with their respective factors. Caloric value (kcal/100g) = (% protein x 4) + (% crude fat x 9) + (% carbohydrate x 4) (Chong and Nor Aziah, 2008).

***Physical analysis***

The volume and specific volume of the muffin were carried out according to AACC (2000). The oven spring was determined according to See *et al.* (2007). The muffin was weighed 1 hour after removal from the oven. The volume (ml) was determined using the rapeseed displacement method and specific volume ($cm^3/g$) was obtained from dividing the volume by loaf weight. Texture profile analysis (TPA) was performed using a TA-EX, Stable Micro System Ltd. under the following conditions: 35 mm diameter cylinder aluminium probe (P/36R), 5 kg load cell, 2.0 mm/s pre-test speed, 10.0 mm/s post-test speed, 1.0 mm/s test speed, auto trigger type. In muffin texture determination, the crust was removed and samples of 20 mm x 50 mm x 50 mm were used. Firmness and springiness were calculated from the TPA result.

***Sensory evaluation***

Forty untrained panelists from the School of Food Science and Nutrition UMS were asked to score the samples in terms of colour, texture, sweetness, sourness and overall acceptability. A 7 point hedonic scale was used in evaluating the sensory attributes of muffins where 1 = strongly dislike and 7 = like very much (Meilgaard *et al.,* 2000). Sensory panelists received a tray with each sample coded by a random 3-digit number, a cup of water, and a questionnaire. Panelists were given one sample at a time. The order of presenting the samples was randomised so that each sample appeared in a given position an equal number of times.

***Statistical analysis***

Data were analysed with SPSS version 12.0 (Illinois, USA) using one-way analysis of variance (ANOVA). Significant differences were tested using Tukey's test.

## RESULTS AND DISCUSSION

***Proximate composition of roselle calyces powder (RCP)***

Proximate composition results for fresh roselle calyces and roselle calyces powder (RCP) are shown in Table 2. Figure 1 shows the roselle calyces powder (RCP).

**Table 2:** Proximate composition of fresh roselle calyces and roselle calyces powder

| Composition (%) | Fresh roselle calyces | Roselle calyces powder |
|---|---|---|
| Moisture | $90.66 \pm 0.24^a$ | $11.27 \pm 0.30^b$ |
| Protein | $2.62 \pm 0.22^a$ | $4.21 \pm 0.01^b$ |
| Fat | $0.15 \pm 0.32^a$ | $0.89 \pm 0.08^b$ |
| Crude fibre | $1.95 \pm 0.22^a$ | $5.57 \pm 0.76^b$ |
| Ash | $1.28 \pm 0.42^a$ | $5.54 \pm 0.67^b$ |
| Carbohydrate[1] | $3.34 \pm 0.93^a$ | $72.52 \pm 1.80^b$ |

*[1]obtained by difference*
**mean values in the same row not followed by the same letter are significantly different (p<0.05). Mean ± standard deviation (n=2)*

**Figure 1:** Roselle calyces powder (RCP)

Results indicated that fresh roselle was significantly (p<0.05) higher in moisture and lower in protein, fat, crude fibre, ash and carbohydrate content than RCP. Moisture content of fresh roselle was similar to the results of Samsudin *et al.*(2000) who reported that fresh calyx contained at least 90% moisture.

***Chemical composition of muffin***
Table 3 shows the proximate composition for different levels of RCP substituted in muffin. The increased substitution of RCP showed a significant (p<0.05) higher moisture content in the muffin with 5, 10, 15 and 20% RCP.

However, the protein composition in the RCP supplemented muffin showed significantly (p<0.05) lower values than the control muffin. This is because the commercial wheat flour has higher protein content (10–14%) (Pankaj *et al.*, 2013; Manuel Gomez *et al.*, 2008) than the RCP (4.21%). Hence, substitution of RCP in the muffin formulation resulted in reduction of protein content due to the reduction of wheat flour in the formulation. This result is comparable to that reported by Chong and Nor Aziah (2008). Fat content in the control muffin was significantly higher (p<0.05) as compared to RCP supplemented muffin, but no significant difference (p>0.05) was observed between all muffins with RCP. This might be attributed to the low fat content in RCP (0.89%) as compared to the wheat flour.

**Table 3:** Proximate composition of muffin at different substitution levels of RCP

| Composition (%) | Control | 5% RCP | 10% RCP | 15% RCP | 20% RCP |
|---|---|---|---|---|---|
| Moisture | 32.56 ± 0.12$^{a}$ | 33.72 ± 0.08$^{b}$ | 34.12 ± 0.04$^{b}$ | 34.57 ± 0.10$^{ab}$ | 35.08 ± 0.22$^{c}$ |
| Protein | 7.83 ± 0.02$^{a}$ | 6.86 ± 0.27$^{b}$ | 6.23 ± 0.03$^{ab}$ | 6.20 ± 0.01$^{ab}$ | 6.11 ± 0.08$^{ab}$ |
| Fat | 12.79 ± 0.44$^{a}$ | 10.82 ± 0.01$^{b}$ | 10.94 ± 0.06$^{b}$ | 11.15 ± 0.12$^{b}$ | 11.57 ± 0.15$^{b}$ |
| Crude fibre | 0.65 ± 0.01$^{a}$ | 0.72 ± 0.02$^{a}$ | 0.89 ± 0.07$^{a}$ | 1.14 ± 0.03$^{b}$ | 1.46 ± 0.21$^{b}$ |
| Ash | 1.77 ± 1.77$^{a}$ | 2.01 ± 0.02$^{b}$ | 2.23 ± 0.03$^{ab}$ | 2.32 ± 0.01$^{ab}$ | 2.43 ± 0.03$^{c}$ |
| Carbohydrate | 44.40 ± 0.61$^{a}$ | 45.85 ± 0.33$^{b}$ | 45.57 ± 0.06$^{a}$ | 44.62 ± 0.20$^{a}$ | 43.39 ± 0.21$^{ab}$ |
| Calorie (kcal/100g) | 324.03$^{a}$ | 308.22$^{b}$ | 305.66$^{c}$ | 303.63$^{cd}$ | 302.13$^{cd}$ |

**mean values in the same row not followed by the same letter are significantly different (p<0.05). Mean ± standard deviation (n=2)*

Table 3 shows that the ash and crude fibre composition in the supplemented muffin were found to be significantly higher (p<0.05) as compared to control muffin. According to Almana (2001), roselle calyx powder or karkade provide an excellent source of calcium, iron and crude fibre indicating the high composition of ash. A similar observation was also reported by Hayashi and Seguchi (1998) where the substitution of 5% karkade in bread increased iron content 7-fold.

The result for carbohydrate content indicated that substitution of RCP in muffin has no significant (p>0.05) effect between samples. This result is in contrast with the study reported by (Olaoye and Onilude, 2008) whereby the carbohydrate content decreased with increasing substitution of breadfruit flour in bread. The calorie value in samples ranged from 302 kcal/100g to 324kcal/100g.

### *Muffin characteristics*

Muffins were prepared by replacing wheat flour at 5%, 10%, 15% and 20% levels of RCP; the physical characteristics of muffins are presented in Table 4.

**Table 4:** Physical characteristics of muffin at different substitution levels of RCP

| Parameter | Control | 5% RCP | 10% RCP | 15% RCP | 20% RCP |
|---|---|---|---|---|---|
| Weight (g) | 61.97 ± 0.93$^{a}$ | 64.27 ± 1.38$^{a}$ | 66.65 ± 0.49$^{a}$ | 67.84 ± 1.58$^{b}$ | 72.42 ± 1.54$^{ab}$ |
| Volume (ml) | 173.50 ± 1.41$^{a}$ | 173.75 ± 0.35$^{a}$ | 170.25 ± 1.06$^{a}$ | 155.75 ± 1.06$^{b}$ | 152.25 ± 1.77$^{b}$ |
| Specific Volume (ml/g) | 2.74 ± 0.10$^{a}$ | 2.64 ± 0.15$^{a}$ | 2.53 ± 0.18$^{a}$ | 2.30 ± 0.04$^{a}$ | 2.10 ± 0.02$^{b}$ |
| Oven Spring[1] | 2.40 ± 0.28$^{a}$ | 1.65 ± 0.07$^{b}$ | 1.55 ± 0.07$^{b}$ | 1.35 ± 0.07$^{b}$ | 1.20 ± 0.14$^{b}$ |
| Firmness (g) | 937.60 ± 27.64$^{a}$ | 960.37 ± 52.51$^{a}$ | 1113.79 ± 27.56$^{b}$ | 1446.23 ± 46.87$^{ab}$ | 1532.68 ± 26.07$^{b}$ |
| Springiness (%) | 59.54 ± 0.02$^{a}$ | 58.33 ± 0.12$^{b}$ | 57.47 ± 0.51$^{b}$ | 51.31 ± 0.24$^{ab}$ | 49.66 ± 0.09$^{c}$ |

**mean values in the same row not followed by the same letter are significantly different (p<0.05). Mean ± standard deviation (n=2)*

*[1] calculated by difference between loaf height before and after baking*

As the substitution level increased from 0% to 20%, the weight of the muffins increased from 61.97 g to 72.42 g and the volume of the muffins decreased from 173.50 ml to 152.25 ml. This might be due to high fiber content in RCP, which increased the water absorption capacity (See *et al.*, 2007) of the RCP and lower gluten content in RCP compared to wheat flour (Chong and Nor Aziah, 2008). Specific volume of the control muffin was significantly higher (p<0.05) as compared to all RCP supplemented muffins. According to Ibrahim *et al.* (1971), karkade powder contains a high level of organic acids; thus, it may react with wheat proteins and hydrolyse the starch to dextrins causing higher viscosity and alkaline water retention capacity (Almana, 2001). This might cause a decreased in volume and specific volume of muffins.

### *Sensory evaluation*

The sensory evaluation scores for colour, sweetness, sourness, texture and overall acceptability were obtained from untrained panelists are presented in Table 5. Supplement of RCP at 5%, 15% and 20% shows no significant ($p>0.05$) differences among samples indicated that panelists were unable to detect the red colour differences in muffins. In sweetness and sourness, all muffin formulations were scored over 5, except 20% RCP muffins, which had the lowest score—3.35 and 3.53, respectively. This might be due to the high content of organic acid in RCP which contributed to the sour taste in the muffin.

**Table 5:** Mean organoleptic scores of muffins prepared by varying proportion of RCP

| Attributes | 5% RCP | 10% RCP | 15% RCP | 20% RCP |
|---|---|---|---|---|
| Colour | $4.23 \pm 1.39^{a}$ | $5.20 \pm 0.91^{b}$ | $5.00 \pm 1.45^{a}$ | $4.78 \pm 1.53^{a}$ |
| Sweetness | $5.38 \pm 0.90^{a}$ | $5.30 \pm 0.88^{a}$ | $4.63 \pm 0.98^{b}$ | $3.35 \pm 0.98^{c}$ |
| Sourness | $5.53 \pm 0.60^{a}$ | $5.15 \pm 0.77^{a}$ | $4.60 \pm 0.84^{ab}$ | $3.53 \pm 1.40^{c}$ |
| Texture | $5.13 \pm 1.24^{a}$ | $5.18 \pm 0.78^{a}$ | $4.85 \pm 0.14^{a}$ | $4.40 \pm 1.15^{ab}$ |
| Overall acceptability | $5.30 \pm 1.22^{a}$ | $5.40 \pm 0.67^{a}$ | $4.28 \pm 1.30^{b}$ | $3.58 \pm 1.30^{c}$ |

**mean values in the same row not followed by the same letter are significantly different ($p<0.05$). Mean ± standard deviation (n=2)*

As shown in Table 5, substituting high levels of RCP in muffin up to 20% reduced the score for texture. This result may be attributed to the firmness of the muffin, which resulted from the low specific volume and springiness in 20% RCP muffins as described earlier (Table 4). According to Knuckles *et al.* (1997), in sensory evaluation, products with score value of more than 5 for overall acceptability can be considered as a good quality product. Though the overall quality scores were reduced, the muffins prepared from 10% RCP were found to be the most acceptable by the panelists.

## CONCLUSION

The result of the present study revealed that roselle calyces powder produced using the spray drying method can be partially substituted for the wheat flour at 10% levels. The 10% RCP muffin is the most acceptable with a good source of fibre and minerals, low fat and calorie value.

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