ABSTRACT

Bananas blossom or known as bananas flowers are one of the Musa genus and can be discovered in many parts of the world, especially in Southeast Asia. It has a wide variety of benefits such as promoting heart health, anti-microbial, improves digestion and also slow aging process. However, some people especially kids and teenagers do not like it as the flower is starchy and slightly bitter, with more vegetal flavors, entirely different than the mature banana fruit. Thus, this study was conducted to evaluate physicochemical properties and consumer preference of Banana blossom nugget, BBN formulated with different percentage of banana blossom and potato flour. Three formulations of BBN were prepared with the percentage of banana blossom to potato flour of BBN were: A (65:25), B (60:30) and C (50:40). Data obtained was analyzed using SPSS software version 17.0. Results found that BBN with formulation C was significantly higher (p<0.05) in hardness compared to A and B, A was significantly lower in chewiness compared to B and C. However, there was no significant differences found in cohesiveness. Meanwhile, all BBN were found significantly different in oil absorption. All BBN were also significantly different (P<0.05) in total protein and fat content. No significant difference (p>0.05) observed in the sensory scores of BBN for colour and texture. However, there was significantly higher (p<0.05) for aroma and lower for flavor of formulation A compared to another BBN. However, hedonic test found that consumers preferred (p<0.05) formulation A and B compared to C. The BBN which contained percentage of banana blossom to potato flour (65:25) was the most preferred by consumer in term of colour, aroma and flavor compared to all BBN. This finding showed that formulation of BBN with banana blossom and potato flour could be accepted by consumers but further research should be focused on the optimized amount of banana blossom in the BBN. Thus, the physicochemical and sensory analysis should be improved by compared to a commercial brand of chicken or beef nugget.

Keywords: Banana blossoms, nuggets, physicochemical, sensory evaluation, hedonic test
1.0 INTRODUCTION

Banana blossom (*Musa acuminata* Colla) is considered as vegetable in many Asian countries such as Malaysia, Thailand, Indonesia and Sri Lanka reported by Kanchana, 2005; Sharina (2014). Banana blossom is blanched and consumed with sambal (chili paste) and steamed rice in Malaysian cuisines. It is claimed as a fibre-rich source that has demonstrated its benefits in health and disease prevention. According to Jayamuthuganai and Elaveniya (2014), banana blossom contains 5.74g/100g dietary fiber. Dietary fibre is important to protect our body from obesity, lower blood cholesterol levels, normalize blood glucose and insulin levels (Vuksan et al., 1999; Chandalia et al., 2000; Jayamuthuganai and Elaveniya, 2014). According to MOA (2011), banana blossom contains high protein and fibre. However, kids and teenagers were avoiding it because it’s slightly bitter taste.

Moreover, the intake of banana blossom is very low among Malaysian especially in metropolitan cities. Besides, the source of banana blossom itself and preparation of banana blossom dish is not easy. Thus, producing any ready to eat food or product that contains banana blossom will attract everyone to consume it easily. Hence, this study was conducted to evaluate physicochemical properties and consumer preference of BBN formulated with different percentage of banana blossom and potato flour.

2.0 LITERATURE REVIEW

Banana (Musa spp.) is one of the most widely cultivated and widely consumed fruit crops in the world. Bananas are native to South East Asia and it is cultivated in over 130 countries throughout the tropical and subtropical regions of the world. With annual world production of bananas around 114 million metric tons from an area of 5.6 million ha (FAO 2018), banana is amongst the world’s major food crops, after rice, wheat and maize. From this total banana production is about 50% consumed in cooked form which is often term plantains while the rest is dessert types. A study by Amir Amini Khoozani (2019) revealed banana is a tropical climacteric fruit and universally comprises a number of species in the genus Musa of the family Musaceae.

Chicken nuggets are one of the processed product that has good nutritional value and affordable. It contain protein, fat, carbohydrates, and minerals. The protein is derived from chicken meat which consists of complete amino acids. Despite having a fairly complete and good nutritional content, chicken nuggets contain high fat and low fibre.

Various researches had been carried out in the processing of nuggets to increase its nutritional content. It had been reported that chicken nuggets had been fortified with addition of other functional ingredients such as broccoli powder extract (Banerjee et al., 2012), ground mustard (Kumar and Tanwar., 2011), rice and protein isolate (Shoaib et al., 2018) and others. Due to rising of veganism and awareness in sustainability, there are driving demand for meat free substitutes such as chickpea and textured vegetable protein nuggets (Sharima-Abdullah et al., 2017), vegetable nuggets (Abd Hamid and Mohd Hassim., 2015) grey oyster mushroom nuggets (Faujan and Husain., 2019) and other ingredient.
Banana blossoms have tremendous nutritional value. They are an excellent source of potassium, fibre and protein plus the vitamins A, C and E. Banana blossoms also a good source of flavonoids. These phytochemicals found in many plant based foods help prevent damage to DNA cells by neutralizing free radicals. They also help to reduce cholesterol, anti-inflammatory, anticancer and anti-aging. Banana blossoms also contain antioxidant and can reduce risk of chronic disease such as cardiovascular disease. Banana blossoms as a source of dietary fibre also able to control obesity and diabetes.

Fig 1.0 Blossom of *Musa paradisiaca*

Source: Divya, R. S., *et al* (2016)

Very few research reports are available on the incorporation of banana blossoms in food items. Tamanna Tasnim *et al.* 2020 reported incorporation of banana blossom flour in plain cake results in a significantly improved retention of color and improved functional properties. It has been found that the banana blossom’s abon with banana blossom and mackarel tuna, really been like by panelists and also high protein content (Jusniati *et al.*, 2017). Elaveniya and Jayamuthunagai, 2014 conducted replacement with banana blossom flour in cookies which increased mineral and protein content of the bakery products. Incorporation of 20% banana blossom in nut chocolate was very desirable in terms of all attributes for hedonic test (Komal and Kaur., 2019). Titik Dwi Sulistiyati *et al.* 2017 demonstrated that concentration of snakehead fish and banana blossom yellow kepok had significantly effects on organoleptic scores and chemical characteristics. Shuchita Anand and Mahak Sharma (2019) discussed hummus dip with concentration of 20g of banana blossom and 3g Indian gooseberry powder was highly acceptable.

### 3.0 RESEARCH METHODOLOGY

#### 3.1 Preparation of Nuggets

The nuggets were prepared according to method explained by Tamsen *et al.* (2018). In order to prepare a nugget paste, banana blossom was washed and soaked with brine for 20 minutes. The
banana blossom was then steamed for 30 minutes. After that, it was grounded and mixed with TVP, premix and potato flour in a food processor. Then, the grinded mixture was poured in the tray and kept in the freezer for 45 minutes. The prepared paste was molded and immersed in a batter before it was finally breaded with breadcrumb. The prepared nuggets were stored at 4°C until further uses. All analyses of the nuggets were performed after the frying step (product ready for consumption).

Three formulations of BBN were prepared with the percentage of banana blossom to potato flour of BBN were: A (65:25), B (60:30) and C (50:40). In statistics, quality assurance, and survey methodology, sampling is the selection of a subset (a statistical sample) of individuals from within a statistical population to estimate characteristics of the whole population. Two advantages of sampling are the cost is lower and data collection is faster than measuring the entire population.

3.2 Physical Analysis

Texture Profile Analysis (TPA)

TPA parameters (hardness, cohesiveness and chewiness) were obtained by texture analyzer Instron universal testing machine, USA. Sample with 1.5 cm diameter and 1 cm thickness was tested using a probe diameter, 2.54 cm; load cell, 5 kg; test speed, 1.00 mm/s; cycle number, 2; and trigger force, 0.1 N.

Oil Absorption

The oil content of nuggets were determined before (w1) and after (w2) frying according to AOAC method (1975). The following equation was used to measure the oil absorption of nuggets.

\[ \text{Oil absorption} = \left( \frac{w_2 - w_1}{w_1} \right) \times 100 \]

3.3 Fat and Protein Analysis

The fat and protein composition of BBNs were analyzed by referring to AOAC methods (1975). Protein was determined by Kjeldahl method (Kjeldahl, 1883), and thereafter a conversion factor of 6.25 was used to calculate the total nitrogen to crude protein. Crude fat was analyzed by the Soxhlet extraction method.

3.4 Sensory Evaluation

Consumer preference of BBN was evaluated in terms of colour, aroma, texture and flavor. A descriptive analysis with line scale scoring test was conducted to compare the different perceptions. An untrained consumer panel by 30 panels (students at Food Technology Department) was used for the evaluation.

All the nugget samples have been deep fried for 104s, cut into the same size and arranged on a plate while the distilled water is served for mouth rinsing. There were BBN samples given at
each sensory evaluation session. The test sample was coded with a three digits random number. Then, the sample permutation was done in order to avoid bias among the panel. The panel is required to deliver intensity score for each attribute in scale. There are four attributes evaluated which were the texture, flavor, color, overall acceptability of nugget.

For hedonic test, panel is asked about their preference in term of texture, flavor, color, overall acceptability of nugget. The samples were evaluated using a 7-point hedonic scale ranging from extreme dislike (score = 1) to extreme like (score = 7).

3.5 Statistical Analysis

In this study, all experiments were done with three replicates. Analysis of variance (ANOVA) was done on the experimental data using SPSS software.

4.0 FINDINGS

TEXTURE PROFILE ANALYSIS

Results of TPA (hardness, cohesiveness and chewiness) are shown in Table 1. Hardness (N) is the maximum force required to compress the sample. Cohesiveness shows the intensity of deformation before tissue destruction. Chewiness indicates work required to chew sample. Hardness for sample C showed significantly (P<0.05) harder compared to other samples. While there was no significant difference (P<0.05) for cohesiveness among samples. The chewiness of formulation A is lower significantly (P<0.05) to other samples and it was reported that addition of bottle gourd (5, 7.5 and 10 g/100 g) decreased the chewiness of low-fat chicken nuggets, according to Verma et al. (2012). Hardness and chewiness were increased by increasing the potato flour content of nugget.

Chewiness ranged from 0.85 to 2.35 N, and it is directly proportional to hardness. Low cohesiveness was found for formulation A (0.85), indicating the reduction of strength of internal bond between bread ingredients (Valcarcel-Yamani and Da Silva, 2013).

According to Sharina (2014), the highest amount of potato flour in formulation contributed to the increasing of hardness of nugget.

During the frying process, the physical and sensory characteristics of the food are modified (Townsend, 1971). There would be changes with the texture of nuggets that would be unacceptable. Therefore, determination of good quality nugget’s texture should be done together with sensory test in order to find out the suitable formulation preferred by consumers.
Table 1. Texture profile analysis of nuggets with different formulations

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Hardness (N)</th>
<th>Cohesiveness (mJ)</th>
<th>Chewiness (mJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.617±0.04a</td>
<td>0.05±0.007a</td>
<td>0.85±0.212a</td>
</tr>
<tr>
<td>B</td>
<td>0.674±0.003a</td>
<td>0.05±0.007a</td>
<td>2.1±0.00b</td>
</tr>
<tr>
<td>C</td>
<td>0.727±0.021b</td>
<td>0.05±0.007a</td>
<td>2.35±0.21b</td>
</tr>
</tbody>
</table>

a,b Significant differences in column (p<0.05).

OIL ABSORPTION

Oil absorption of nuggets with different formulations are shown in Table 2. Oil absorption of nuggets decreased by increasing the amount of banana blossom. Preeti Preethi and Balakrishna (2013) reported that banana blossom is a major source of fibre. According to Ang and Miller (1991), commercially available batter mixes added with cellulose fibre enabled a reduction of fat absorption by 30% in battered chicken strips and 35% in battered fish fillets. Another report by Mesias et al. (2016). The addition of chia flour in the chicken nuggets showed no major differences (p>0.05) in the oil absorption, which ranged from 9.46−10.30 g/100 g.

Oil absorption behavior is an important parameter that affects the quality of fried food, and many studies have attempted to explore the oil uptake of food during deep frying (Blumenthal, 1991; Bouchon et al., 2003; Chen et al., 2019; Dana and Saguy, 2006; Su et al., 2017). The viscosity and surface tension of the frying oil affect the wettability of the oil and food during the frying process, the heat transfer and mass transfer rate, the draining of oil during the post-frying and cooling stages, and also the oil content.

As reported by Chen et al. 2020. Reduction in oil content about 21.5%, 30.6%, and 34.9% with the addition of 1%, 3%, and 5% pullulan (polysaccharide), indicated that the addition of pullulan successfully exerted the reduction in fat absorption in a dose-dependent manner.

Zhang et al. (2018) reported the reason may be because of the higher moisture content of the potato chips and vigorous vaporization hindered the oil absorption of the interior in the initial stage of frying. With the frying process continuing, the pore or voids volume increased due to the evaporation of water. Therefore, more oil penetrated into the interior of the sample leading to oil absorption increased eventually.
Table 2. Oil absorption of nuggets with different formulation

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Mean of oil absorption±SD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.63±0.323a</td>
</tr>
<tr>
<td>B</td>
<td>13.24±1.207c</td>
</tr>
<tr>
<td>C</td>
<td>12.63±2.189b</td>
</tr>
</tbody>
</table>

a,b,c Significant differences in column (p<0.05).

PROTEIN AND FAT COMPOSITION

Protein and fat content of three formulations of BBNs are presented in Table 3. The protein content in formulation A was significantly higher than B and C due to the use of 65% of banana blossom. According to MOA (2011), banana blossom contained 1.6 per 100 g protein. Sheng et al. 2010 also showed the content of protein varied from 1.62 to 2.07 g/100g in banana flower. It is also well known that banana flowers contain a significant amount of non-protein nitrogen, generally in the form of chitin in their cell walls. Begum (2018) reported protein content of inner bract of banana flower powder is 2.55%. Fortification of nuggets as reported by Mesias et al. (2016) showed the addition of chia flour increased (p < 0.05) protein content of the chicken nuggets when compared with the control formulation, due to the high protein content of chia flour (19.8 g/100 g).

In contradict, the fat content of formulation C is significantly higher than A and B due to fat concentration was generally low (0.4g/100 g Baxijiao and 0.6 g/100 g Paradisiaca) in both cultivars (Shen et al., 2010). The levels of fat was found to be low in dried banana blossom powder 0.41 –0.46 g /100g respectively than the fresh sample (Begum, 2020).

Table 3. Protein and fat composition of nuggets with different formulation

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Protein (g/100g)</th>
<th>Fat (g/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2.265±0.064c</td>
<td>0.647±1.414a</td>
</tr>
<tr>
<td>B</td>
<td>0.885±0.049a</td>
<td>0.725±2.192b</td>
</tr>
<tr>
<td>C</td>
<td>1.25±0.0040b</td>
<td>0.875±2.828c</td>
</tr>
</tbody>
</table>

a,b,c Significant differences in column (p<0.05)
SENSORY EVALUATION

The scoring test of BBN was described with 1 to 5 scales, with 1 represents the lowest features and 5 represents the highest features. Results of scoring test of nuggets (Table 4) showed that all formulations did not vary significantly (p<0.05) in colour and texture compared to higher significant in formulation A for aroma attribute and formulation C for flavour attribute.

Aroma of formulation A is noticeable compared to others. While flavour of the nugget increased disproportional to the percentage of banana blossom being added.

This result is in accordance with previous study which reported that sensory quality of fish fillets was indicated by textural properties and flavors more than appearances and colours (Phan and Nguyen, 2012).

Table 4. Scoring test of nugget with different formulations

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Colour</th>
<th>Aroma</th>
<th>Texture</th>
<th>Flavour</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>3.27±1.617&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.30±2.231&lt;sup&gt;b&lt;/sup&gt;</td>
<td>3.73±1.741&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.37±1.450&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>B</td>
<td>2.63±1.829&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.87±1.978&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.03±1.326&lt;sup&gt;a&lt;/sup&gt;</td>
<td>3.10±1.788&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>C</td>
<td>2.73±1.596&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.53±1.676&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.77±1.406&lt;sup&gt;a&lt;/sup&gt;</td>
<td>4.00±2.017&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b</sup> Significant differences in column (p<0.05).

Table 5 showed results for hedonic test, consumer preferred formulation A for aroma and formulation C for texture. For overall acceptance, formulation A was preferred by consumer.

Anand (2019) showed that most of panelist found T2 (Hummus incorporated with 20g of banana blossom and 3 gm Indian gooseberry powder sample) highly acceptable (8-like very much and 7-like moderately) in term of colour, taste, texture, aroma, appearance and overall acceptability as compared to other samples respectively.

According to Salvador (2012), the banana blossom “sisig” is accepted to the tasters but there is still a need to improve not only the taste but also the colour, the appearance and texture since there are many respondents who evaluated the variables as “like moderately”.

There was report by Lopez (2015) showed that incorporation of banana blossom in formulation of carablossom burger was rated as liked very much, while colour was liked moderately for flavor and general acceptability. Juiciness, texture, and spiciness were described as slight and saltiness was moderate.

Begum et al. (2020) found that increasing level of DF addition (4 g per 100 g) in the flour mixture influences the sensory attributes negatively with poor overall acceptability due to the hard texture and specific taste of DF. Hence, addition of 2 g per 100 g DF of flour mixture with 66 g per 100 g
moisture can be successfully used for making DF fortified bread with a high consumer acceptability.

### Table 5. Hedonic test of nugget with different formulations

<table>
<thead>
<tr>
<th>Formulations</th>
<th>Color</th>
<th>Aroma</th>
<th>Texture</th>
<th>Flavor</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6.00±0.947a</td>
<td>6.00±0.695b</td>
<td>3.77±1.755a</td>
<td>5.57±1.413a</td>
<td>5.57±1.382b</td>
</tr>
<tr>
<td>B</td>
<td>6.00±1.661a</td>
<td>5.43±1.135a</td>
<td>4.40±1.773b</td>
<td>4.77±1.455a</td>
<td>5.20±1.424b</td>
</tr>
<tr>
<td>C</td>
<td>4.13±2.030a</td>
<td>5.63±0.765a</td>
<td>5.30±1.055a</td>
<td>4.60±1.734a</td>
<td>4.50±1.834a</td>
</tr>
</tbody>
</table>

\[a,b\] Significant differences in column (p<0.05).

### 5.0 CONCLUSION

Results of this study showed that different ratio of banana blossom to potato flour had affected to the hardness and cohesiveness of BBN. The BBN with formulation A (65:25) that contained the highest protein and lowest fat content was the most preferred by consumer in term of colour, aroma and flavour compared to all BBN. This finding showed that formulation of BBN with banana blossom with potato flour could be accepted by consumers but further research should be focused on the optimized amount of banana blossom in the BBN. As banana is diversely available all over the world, its byproducts can be commercially used as rich sources of a lot nutrients for formulating better quality nuggets with potential health-beneficial effects. Therefore, it should be reasonable to conduct more investigation in correlating the multi factorial of BBN nuggets with their textural properties without losing its nutritional value.

### REFERENCES


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