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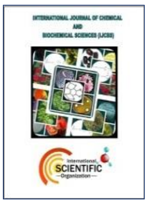

# The Nutritional Content and Sensory Qualities of Jelly Sticks Formulated with Different Proportions of Puree and Mucilage of Okra (*Abelmoschus esculentus*)

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**Abstract**

Okra is a nutritious and versatile vegetable with a wide range of potential applications, yet prior studies focused only on mucilage part. The effect of green okra jelly sticks was investigated in this study. Jelly sticks were developed and formulated with the main ingredients by comparing the proportions of okra mucilage and puree at three levels of treatment (1:2, 1:1, and 2:1), and evaluated for their nutritional content, texture, pH levels, and sensory qualities. The proximate properties (dry basis) showed moisture content ranged from 94.75-94.88%, ash (21.29-22.43%), fat (2.19-2.21%), protein (13.32-17.35%), and carbohydrates (59.00-62.36%). The data indicate that the ratio of puree and mucilage in green okra significantly affects the protein and carbohydrate content of the jelly sticks. In terms of textural and pH levels, the hardness was around 182.66-209.11 g.force, gumminess (81.33-94.66 g.force), and pH (4.99-5.08). The findings of this study showed that among the jelly sticks that have been formulated, jelly with a formulation of 2:1 mucilage and puree had the highest sensory acceptance.

**Keywords:** Jelly stick, mucilage, okra

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## 1. Introduction

Dietary guidelines regarding fruit and vegetable consumption vary between countries. However, it is agreed that improving their intake can enhance general health and lower the likelihood of major non-communicable diseases. Intake of fruits and vegetables and the occurrence of degenerative diseases such as diabetes mellitus and cardiovascular disease have been observed through research [1-2]. The benefits of fruits and vegetables are crucial to promoting health due to their nutrients, such as vitamins, minerals, antioxidants, and dietary fibre [3-4].

Okra (*Abelmoschus esculentus* L.), also known as lady's finger, is one of the vegetables that are rich in nutrients and bioactive components that promote health. It can be prepared in numerous ways and is grown in areas characterised by tropical and subtropical climates, making it adaptable for cultivation in both household gardens and expansive commercial farms [5]. The immature green pods of okra are usually consumed as vegetables, while the extract of the pods also serves as a thickening agent in numerous recipes for soups as well as sauces to augment their viscosity [6-7].

This plant is considered a valuable crop due to the multiple functions of its leaves, buds, flowers, pods, stems, and seeds, which can be utilised for both nutritional and medicinal uses [8]. Another noteworthy application of okra fruit is its wide use in the pickle industry. The polysaccharides present in okra are used in sweetened frozen foods such as ice creams, as well as bakery products, due to their health benefits and longer shelf lives [9-10]. Additionally, okra pods have also been recommended to cure dysentery, gonorrhoea, and urinary complications. Okra seeds have been used as an anticancer and fungicide [11].

Okra pods are known for their abundant nutritional content and are commonly eaten following various cooking methods such as boiling, frying, or cooking [12]. The main components of okra plant mucilage are predominantly carbohydrates [13]. The mucilage extracted from okra is a mixture of polysaccharides, which include the monosaccharides D-galactose, L-rhamnose, and galacturonic acid. Moreover, the levels of Zn and Ca within okra mucilage exceed the mineral content found in the entire okra fruit [14-15].

Previous research efforts have explored the development of functional food products using okra, for instance, jelly drinks and jelly candy [16-17]. However, these studies focused solely on the potential of the mucilage component of okra, leaving the pods untapped. This approach may have limitations in providing a comprehensive understanding of the crop's nutritional properties and potential applications. Exploring both parts of okra could offer a more holistic perspective on the versatility and nutritional value of okra, which may lead to broader applications and insights, such as food science and nutrition. Therefore, this study aimed to compare the mucilage and puree of okra, analysing the impact on a product's nutritional content and physical characteristics.

This vegetable is both nutritious and versatile in culinary applications, offering valuable health benefits. Yet, its utilisation in Indonesia needs to be improved and explored. Okra's mucilage contains a combination of hydrophilic and hydrophobic compounds, making it suitable for various applications such as stabilisers, thickeners, and gelling agents [17]. This unique characteristic of okra, enriched with mucilage, is particularly well-suited for the production of jelly products. In this context, the present study aimed to formulate jelly sticks using okra by comparing its mucilage and puree. The objective was to analyse the nutritional composition and sensory properties of the products, providing insights into their potential as nutritious and appealing food options.

## 2. Materials and methods

### *2.1. Material*

*Abelmoschus esculentus* L. pods were procured from the Experimental Farm of IPB University in Bogor, Indonesia. The okra pods used in this study were harvested 5-7 days following the blossoming of the flowers. The other ingredients are water, kappa-carrageenan (IndoGum, Indonesia), konjac, suji leaf extract, lemon juice, vanilla powder, potassium citrate, and stevia sweetener (Drip Sweet CV. Oil M3, Indonesia).

### *2.2. Preparation of Puree and Mucilage of Okra*

The okra pods were cleaned and blanched at 90-95ºC for 30 seconds, then cooled for 30 seconds using water and ice cubes. This aimed to prevent the undesirable colour changes by inactivating the enzymes and also help to maintain the stability of beneficial compounds throughout processing and storage [18]. Some of the blanched pods will be used to produce mucilage of okra, while the remaining will be made into okra puree. To make the mucilage, the sliced pods were macerated for 12 hours at room temperature using water with the ratio of okra and water 1:3 [19]. Then, it was filtered to separate the mucilage. The process of making a puree of okra involves slicing the pods before they are mashed using a blender until they have a smooth texture.

### *2.3. Jelly Stick Formulation and Preparation*

The formulation of the okra jelly stick was modified from [16]. The main ingredients in this study were the mucilage and puree of okra, which resulted in three formulas based on the ratio of both ingredients (1:2, 1:1, and 2:1). The gelling agents used in this study were 3% kappa-carrageenan and konjac glucomannan (2:1).

Additionally, to produce a stronger gel, potassium citrate was also used (0.15%) [20]. The prepared jelly sticks were stored in a chiller at a temperature of 4-5 ºC.

### *2.4. Proximate Content*

Proximate analysis was determined according to Association of Official Analytical Chemists (AOAC 2005), which involved moisture (AOAC 986.21), ash (AOAC 900.2), fat (AOAC 920.39C), protein (AOAC 955.04), and carbohydrates of the okra jelly stick. The carbohydrate content was determined using the by-difference method.

### *2.5. Texture Profile and pH Analysis*

The measurement was determined by a texture analyzer (Stevens-LFRA Texture Analyzer) according to Yusof *et al.* (2019), with some modifications. A cylindrical probe was used to compress the jelly sticks with a 5 mm target distance and a compression rate of 1.0 mm/s. The test was done in triplicate and conducted at room temperature. The texture profile analysis (TPA) of the okra jelly sticks included such parameters as hardness and gumminess. The pH measurement was performed using a pH metre (Ohaus Starter 3100, USA), which underwent an initial calibration using a buffer solution at pH values of 4.00, 7.00, and 10.00. All experiments were carried out in triplicate.

### *2.6. Sensory Evaluation*

The sensory tests consist of hedonic quality, hedonic rating test, and quantitative descriptive analysis (QDA), which were conducted in the Organoleptic Laboratory of the Human Ecology Faculty of IPB University, Indonesia.

#### *2.6.1. Hedonic Quality and Hedonic Rating Test*

The evaluation involved a semi-trained panel consisting of 30 judges from IPB University who provided their written informed consent. Hedonic quality was assessed using a nine-point hedonic scale to assess the intensity of jelly sticks' characteristics (Table 4). A hedonic rating test was performed using a similar method to hedonic quality. This evaluation aimed to measure the level of preference for the product that ranged from 1 to 9 (1 = dislike extremely; 2 = dislike very much; 3 = dislike; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like; 8 = like very much; 9 = like extremely). The panellists were first conducted to their individual booths and received instructions about the use of the specific scale to be used and the type of evaluation to be carried out. The samples were evaluated monadically. Each panellist was given one package (20 grams) for each sample that was served under white light at refrigerator temperature (10-15ºC) on dessert plates with random three-digit numbers. The tasters were asked to taste each sample and evaluate their intensity of attributes and degree of liking. As for the hedonic rating test, a sensory score equal to or greater than 5 was considered acceptable, while a score under 5 was rated as unacceptable.

#### *2.6.2. Quantitative Descriptive Analysis (QDA)*

The QDA was carried out to evaluate the attributes of the samples in order to obtain a comprehensive sensory profile. A total of eight tasters were selected tasters from IPB University students who had completed pre-selection (colour recognition test, basic taste recognition test, and triangular method).

The panellists then conducted a focus group discussion under the supervision of a moderator. The jelly stick samples were presented and the tasters were asked to describe similarities and differences between them in sensory terms, resulting in descriptive terms generated with definitions. The listed terms and their definitions are presented in **Table 1**. After the discussion session, the products were evaluated concerning the attributes identified by the selected tasters on 0-10 scales previously defined by the team, presented monadically on dessert plates (20 grams of each sample) encoded with three-digit numbers. The test was conducted in individual booths to maintain the isolation of each tester. The judges received the samples along with a glass of water at room temperature and an evaluation form containing the descriptive terms and their scale.

#### *2.7. Analytical Statistic*

All the assays related to physicochemical determination were carried out in triplicate. The chemical analyses were reported on a moisture-free basis. The data was processed using Microsoft Excel 2019 and analysed using IBM Statistical Programme for Social Science (SPSS) version 23. The moisture, ash, fat, protein, carbohydrate, and sensory acceptability data were analysed for analysis of variance (ANOVA), and the mean values were evaluated for statistical significance ($p<0,05$) using the Duncan's Multiple Range Test.

## 3. Results and Discussions

### *3.1. Proximate Analysis*

#### *3.1.1. Moisture Contents*

Based on the data presented in **Table 2,** the proximate contents reveal that the treatment only affected protein and carbohydrate contents of jelly sticks. The findings related to moisture analysis indicate that the three formulas had a high moisture content which was around 94%. The increasing ratio of mucilage to the formula did not incline the water content of it. Similar findings are reported for jelly drinks produced from a combination of okra and pineapple, with an approximate yield of 94% [23]. Products with high moisture levels contain greater quantities of free and chemically unbound water, which can enhance biological processes and affect the product's shelf life [24].

#### *3.1.2. Ash Contents*

The ash content of okra jelly sticks ranged from 21.29% to 22.43%, demonstrated an increasing trend of ash in F3, although it did not differ significantly. The results are shown in Table 2. The ash content was found to be high in all three formulas. These findings are supported by Williams *et al.* (2023) who reported that the ash content of okra residue after pectin extraction is around 19.55% to 21.99%. The higher ash content suggests that there is a greater abundance of minerals [26]. Data obtained from the USDA SR-21 indicates that okra possesses significant mineral content, including calcium, phosphorus, and iron [6].

#### *3.1.3. Fat Contents*

The fat content of okra jelly sticks was recorded in the range of 2.19%-2.21%. It is meticulously seen from Table 2 that the different proportions of puree and mucilage of okra in the jelly sticks do not impact the fat content of the product. This result is in accordance with research by Gemede *et al.* (2016) which reported the fat content in okra pods ranged from 0.56-2.49 g/100 g (dry bases).

#### *3.1.4. Protein Contents*

The protein of the jelly stick samples was found to be between 13.32%-17.35% which differs significantly. Interestingly, the F1 sample indicated the highest protein content at 17.35%. This can be attributed to the inclusion of okra seeds during the preparation of okra puree. Research findings indicate that okra seed flour contains a protein content of 26.42 g per 100 g on a wet basis [28]. Amounts of protein is depicted in **Table 2**.

#### *3.1.5. Carbohydrate Contents*

Statistically, the carbohydrate content of the samples was significantly different which varied from 59.00% to 62.36%. It is clearly seen from Table 2 that the F3 sample was the highest among the formulas (62.36%). This observation can be linked to the mucilage of okra, which contains pectin, a polysaccharide known for its water-soluble properties [29]. The findings are lower than the values reported for okra juice on wet bases, which are around 11.7%-14.00% [30].

### *3.2. Physical Characteristics*

#### *3.2.1. Texture Analysis*

**Table 2** illustrates that the jelly stick with a proportion of mucilage higher than the puree (F3) had the highest value of hardness and gumminess. On the contrary, the lowest one was found on the F1 (the puree twice of the mucilage). This result from mucilage polysaccharides with high molecular weight, capable of dissolving and dispersing in water. Their interaction with water, causing expansion, makes mucilage suitable for food additives and texture modification as gelling agents [31]. Another observation by Xu *et al.* (2019) reported that the addition of okra polysaccharide in yogurt enhanced its water-holding capacity, which offered information regarding the stability of gel in samples.

#### *3.2.2. pH Measurement*

pH, which measures the level of hydronium ions ($h_3o^+$) in a substance, plays a pivotal role in influencing the chemical reaction process and, consequently, the overall product quality, especially in the field of food and biochemical processes [33]. The pH values for the formulations fell within the range of 4.99 to 5.08, which can be categorised as acidic products. The acid condition was due to the addition of lemon in all formulas in order to neutralise the unpleasant flavour of okra. The findings are presented in **Table 2**.

### *3.3. Sensory Evaluation*

#### *3.3.1. The Hedonic Rating Test*

The hedonic test was performed to evaluate the formula preferred by the panellists for various sensory attributes (**Table 3**). Every class received a rating that ranged from dislike extremely to like extremely. Greater scores imply stronger preferences. The F3 sample was selected as the most preferred product for gel clarity by 6.57 ($p<0.05$). The increased proportion of mucilage in the formula enhances the transparency of the jelly sticks, as the presence of okra puree fibres influences the jelly's colour clarity.

A similar result was reported by Giyatmi *et al.* (2022). They observed that an increased concentration of okra puree leads to a decreasing level of preference among panellists for the colour of pudding. Good acceptance for texture was received by the F3 sample at 6.68 and this mean score was different significantly from the others. This aligns with the findings of texture analysis in **Table 2**, where the F3 sample demonstrated the highest value. It suggested that the addition of mucilage into jelly sticks improves both their texture and the acceptance of the panellists. As for the flavour, the F3 formula emerged as the most favoured choice (5.45). This can be related to the dominant taste of okra present in the puree rather than in the mucilage, which significantly influences panellists' preferences for the jelly stick's flavour. When the okra concentration in a nugget surpasses that of Tempe, the preference rating drops because the vegetable flavour of okra tends to conceal the taste of Tempe [34].

The formula with the proportion of mucilage was higher than the puree (F3) indicating that okra produced a jelly stick with a higher likeness for mouthfeel than the other samples (5.31) and is significantly different. In the F1 and F2 samples, the puree content was higher, resulting in a granular texture inside the mouth that affects acceptability. Mouthfeel refers to the various physical or tactile feelings in the mouth when consuming foods and beverages. In addition to taste and aroma, mouthfeel plays a vital role in determining product acceptance and preference [35-36]. The range of statistical scores for the aftertaste ranges between 3.88 to 5.32 with the F3 obtained the highest mean score ($p<0.05$). This finding suggested that the F3, which had a higher okra mucilage, had an aftertaste attribute that was more acceptable to judges compared to other formulas. The lasting flavour that lingers after consuming a meal is a vital flavour in assessing the palatability of food. Among all the jelly sticks, the F1 formula, which had the highest puree ratio, showed the lowest mean score for all attributes, with an overall score of 4.01. Conversely, the F3 formula consistently gained the highest scores of all, resulting in an overall score of 6.03, signifying a slight preference for it.

### *3.3.2. The Hedonic Quality*

The hedonic quality test was used to assess the impression of the characteristics of the product's attributes. Greater scores indicate a stronger intensity of attributes. Table 4 provides information regarding the attributes and the scores for the hedonic quality of jelly products. The scores for gel clarity vary significantly for the three formulations, in which the F3 sample obtained the highest average score (5.33), indicating that it has the clearest appearance and is likely perceived as more visually appealing.

This finding was in line with the hedonic rating test with the F3 sample being more favoured than the others. As for the colour attribute, the F1 sample showed a significant difference between the other formulations and received the lowest score of intensity (2.51). The colour of food products can strongly influence consumer perception and preference. This was evidenced by the result of hedonic rating test with the least preference for the colour attribute was received by the F1 formula. Regarding the texture attribute, the mean score of the F3 formula was significantly different from the others. The F3 score presented the chewiest texture compared to the others (6.68), suggesting that it has more appealing texture. It also supported by the findings from hedonic rating test in which the F3 sample reached the highest score for panellists' preferences. Flavour scores showed a similar trend to gel clarity with the highest score of the F3 by 5.34. The results were in accordance with the hedonic rating test for flavour attribute, which indicates that this formula was the most preferred formulation in terms of flavour.

**Table 1:** Descriptor and explanation of the quality parameters of jelly stick

| Descriptor | Definition |
|---|---|
| **Appearance** | |
| Colour | The intensity of the visible green colour. |
| Smoothness | The condition of the surface, whether it has cracks and bumps or not. |
| Homogeneity | The colour uniformity of the product. |
| **Aroma** | |
| Okra aroma | Vegetable aroma produced by okra. |
| Vanilla | The fundamental scent produced by synthetic vanilla extract. |
| **Texture** | |
| Sliminess | Presence of thick and sticky sensations in the sample when touched. |
| **Flavour** | |
| Sweetness | The fundamental flavour sensation produced by the stevia liquid. |
| Bitter | The fundamental flavour sensation produced by the stevia liquid. |
| Vegetable | The scent of vegetables produced by okra. |
| **Mouthfeel** | |
| Sliminess | Degree of which the product gives a feeling of mucus/slime in mouth. |
| Fibrous | The presence of fine fibres in the mouth produced by okra pods. |
| Grainy | The presence of small or granular structures in mouth. |
| **Aftertaste** | |
| Sweetness | The fundamental flavour sensation after consuming the product. |
| Bitter | The fundamental flavour sensation after consuming the product. |
| Vanilla | The taste that remains in the mouth after consuming the product. |

**Table 2:** The physicochemical properties of okra jelly sticks

| Characteristics | F1 (1:2) | F2 (1:1) | F3 (2:1) |
|---|---|---|---|
| Moisture (%) | 94.86±0.11 | 94.88±0.11 | 94.75±0.14 |
| Ash (%) * | 21.29±1.40 | 21.66±0.19 | 22.43±1.45 |
| Fat (%) * | 2.20±0.61 | 2.21±0.49 | 2.19±0.46 |
| Protein (%) * | 17.35±0.65[b] | 16.60±0.70[b] | 13.32±0.36[a] |
| Carbohydrate (%) * | 59.00±1.11[a] | 59.73±1.01[a] | 62.36±1.66[b] |
| Hardness (g.force) | 182.66±0.87[a] | 198.22±0.84[b] | 209.11±2.7[c] |
| Gumminess (g.force) | 81.33±1.00[a] | 91.22±0.50[b] | 94.66±2.33[c] |
| pH | 5.08±0.01 | 5.05±0.01 | 4.99±0.01 |

*%dry basis
Values with different superscripts differ significantly in a row (p<0.05).
Mean ± S.D.

**Table 3:** The hedonic rating test of okra jelly stick

| Attributes | Hedonic score | | |
|---|---|---|---|
| | F1 (1:2) | F2 (1:1) | F3 (2:1) |
| Gel clarity | 4.50±1.65[a] | 5.17±1.76[a] | 6.49±1.60[b] |
| Colour | 5.45±1.71 | 5.54±1.73 | 6.05±2.14 |
| Aroma | 4.51±2.39 | 5.05±1.90 | 5.75±2.18 |
| Texture | 4.43±1.70[a] | 5.27±1.76[a] | 6.68±1.75[b] |
| Flavour | 3.95±1.77[a] | 4.68±1.73[ab] | 5.45±2.02[b] |
| Mouthfeel | 3.49±1.62[a] | 4.23±1.17[a] | 5.31±2.08[b] |
| Aftertaste | 3.88±1.54[a] | 4.41±1.27[a] | 5.32±1.64[b] |
| Overall | 4.01±1.85[a] | 5.19±1.65[b] | 6.03±1.62[b] |

Hedonic test assessment using a 1-9 hedonic scale (1=dislike extremely, 5=neither like nor dislike, 9=extremely like).
Values with different superscripts differ significantly in a row (p<0.05).
Mean ± S.D.

**Table 4:** The hedonic quality assessment of okra jelly stick

| Attributes | Hedonic quality score | | |
|---|---|---|---|
| | F1 (1:2) | F2 (1:1) | F3 (2:1) |
| Gel clarity | 3.75±1.99[a] | 4.29±2.08[ab] | 5.33±2.30[b] |
| Colour | 2.51±1.77[a] | 3.98±2.54[b] | 4.09±2.05[b] |
| Aroma | 6.27±2.25 | 6.13±1.94 | 5.58±2.25 |
| Texture | 5.42±1.96[a] | 5.64±2.06[a] | 6.68±1.92[b] |
| Flavour | 3.75±1.80[a] | 4.62±2.08[ab] | 5.34±1.65[b] |
| Mouthfeel | 6.11±2.14 | 6.36±1.82 | 5.55±2.00 |
| Aftertaste | 5.95±1.99 | 5.76±2.15 | 5.46±2.15 |

Hedonic quality attributes scale using a 1-9 score of intensity: clarity (1=very turbid, 9=very clear), colour (1=light green, 9=dark green), aroma (1=very light, 9=very strong), texture (1=very soft, 9=very chewy), flavour (1=very bitter, 9=very sweet), mouthfeel (1=very light, 9=very strong), aftertaste (1=very light, 9=very strong).
Values with different superscripts differ significantly in a row (p<0.05).
Mean ± S.D.

**Table 5:** Means sensory scores for quantitative descriptive analysis of okra jelly stick

| Attributes | Hedonic quality score | | |
|---|---|---|---|
| | F1 (1:2) | F2 (1:1) | F3 (2:1) |
| **Appearance** | | | |
| Colour | 3.25±0.46[a] | 4.63±0.51[b] | 5.63±0.51[c] |
| Smoothness | 6.38±0.51 | 6.50±0.53 | 6.38±0.51 |
| Homogeneity | 3.00±0.75[a] | 4.38±0.51[b] | 4.50±0.53[b] |
| **Aroma** | | | |
| Okra aroma | 4.25±0.88 | 4.63±0.74 | 5.00±0.75 |
| Vanilla | 2.88±0.83 | 2.75±0.88 | 2.75±0.88 |
| **Texture** | | | |
| Sliminess | 3.25±0.46[a] | 4.63±0.51[b] | 6.38±0.51[c] |
| **Flavour** | | | |
| Sweetness | 2.75±0.70 | 2.63±0.51 | 2.50±0.53 |
| Bitter | 1.50±0.53[a] | 2.75±0.70[b] | 3.38±0.74[b] |
| Vegetable | 4.38±0.51[a] | 5.38±0.51[b] | 7.63±0.51[c] |
| **Mouthfeel** | | | |
| Sliminess | 3.38±0.51[a] | 5.13±0.83[b] | 6.25±0.70[c] |
| Fibrous | 5.50±0.53[a] | 3.63±0.51[b] | 1.88±0.35[c] |
| Grainy | 5.88±0.83[c] | 3.88±0.64[b] | 2.38±0.74[a] |
| **Aftertaste** | | | |
| Sweetness | 2.38±0.74[b] | 1.38±0.51[a] | 1.13±0.35[a] |
| Bitter | 1.13±0.35[a] | 2.00±0.75[b] | 2.25±0.70[b] |
| Vanilla | 1.38±0.91 | 0.88±0.35 | 0.88±0.35 |

Intensity of attribute: 0=none, 10=extremely strong
Values with different superscripts differ significantly in a row ($p<0.05$).
Mean ± S.D.

***3.3.3. Quantitative Descriptive Analysis***

QDA method is acknowledged as an effective tool for assessing and improving the sensory qualities of diverse food products. The core principle of QDA involves instructing judges to evaluate the particular quality aspects of a product to generate quantitative descriptions that can be subjected to statistical analysis [37]. The average values of each sensory attribute are presented in **Table 5.** Based on the colour attribute, a significant difference was observed among all the assessed formulations, with the F1 sample presenting the lowest score and the F3 as the highest one. These findings were in accordance with the results of hedonic quality (gel clarity), which can be concluded that the higher mucilage content in the sample showed a darker colour of green in the analysis of the panellists. Colour is a vital parameter of appearance that influences consumer's perception of a product and is associated with particular tastes [38]. The homogeneity of the F1 had the lowest average score (3.00) and was found to be significantly different than the other formulas. This might be due to the higher content of okra puree which contains a whole okra pod, including peel and seeds, thereby leading to a difficulty in achieving a homogenous blend with food colouring. The visual presentation of food significantly shapes consumer's perceptions of quality and their preferences for a particular food product, which includes consideration of colour uniformity [39].

Texture significantly influences the overall acceptability and eating quality of jelly sticks. In this study, the slimy characteristic of the products' texture was evaluated. It can be observed that there was a significant difference between the F3 sample and the other two samples, The F3 sample obtained the highest average score of 6.38, signifying a prominent slimy characteristic. This result can be attributed to the notably higher mucilage content in the F3 formula, renowned for its thick and viscous texture [40]. Concerning the flavour attribute, the F3 sample showed the highest intensity scores for both bitterness and vegetable taste by 3.38 and 7.63 respectively. The findings suggested that the addition of okra mucilage in jelly sticks can influence the bitter and vegetable taste of the samples. The bitter taste in this study might be caused by the use of stevia as a sweetener which is 300 times sweeter than sucrose, making it a potent natural sweetener.

Despite this potential, its commercial use in food products is limited by its bitterness and lingering aftertaste, which restrict its application as a high-potency sweetener [41]. Moreover, further research is required to evaluate the association of okra puree and mucilage, and the addition of stevia as the sweetener regarding the bitter flavour in food products. Regarding the mouthfeel of the jelly sticks analysed, differences were observed among all samples. The results of the mouthfeel indicated that the F3 product was among the slimiest, yet less fibrous and grainy, meanwhile the F1 was the opposite.

The sensory attribute of slimy mouthfeel was the least pronounced in the F1 product, aligning with the findings on slimy texture attributes. As for the fibrous mouthfeel, panellists noted the highest presence of fibres was in the F1 sample, which also consisted of the highest puree content among all formulas. This was attributed to the inclusion of the whole okra, including the pod's skin, which remained partially intact during blending, resulting in a noticeable fibrous texture when consumed. Furthermore, a grainy texture in jelly was characterised by the presence of small and granular particles, causing a gritty sensation. These structures can lead to an unpleasant mouthfeel, as they disrupt the smooth and homogenous texture expected in food products [42-43]. Graininess in jelly sticks can be linked to various factors, such as incomplete gelation, crystallization of sugar, or the presence of insoluble particles, including components from okra pods such as the peel and seeds. Regarding the aftertaste attribute, tasters identified three flavours, but there were only two aftertaste attributes (sweet and bitter aftertaste) that were significantly different in statistics.

Sweetness results indicated a similar pattern to sweetness in flavour attribute even though it was not statistically different in flavour. As for bitterness, the findings were also in accordance with bitterness in taste attribute, yet the bitter aftertaste intensity was not as strong as in the flavour. Bitterness can also be affected by the results of protein hydrolysis and phenolic compounds. During the process of protein hydrolysis, it is common for intensely bitter amino acids to be released into the solution, which can restrict the utilisation of these substances in foods. Furthermore, the bitterness of a peptide is influenced by factors such as the sequence and polarity of the amino acids it contains, the size of the peptide, the presence of amino acids that inhibit flavour, as well as the pH and temperature conditions [44-45]. Additionally, bitterness is linked to phenolic compounds, such as quercetin, which represent the most common bitter substances found in unripe fruits. Generally, lower-molecular-weight phenolic compounds tend to give a bitter taste. Other factors that can influence the quantities of phenolic content and the intensity of bitterness are genetic factors, ripeness level, surrounding environment, as well as processing and storage conditions [46].

## 4. Conclusions

The data revealed that the different proportions of the puree and mucilage of okra statistically affected only on the protein and carbohydrates contents. However, the sensory qualities evaluated for all methods showed that the preferable formula was obtained by the sample which contained the most abundant mucilage (F3). These results suggested that the okra puree and mucilage did not impact significantly on overall nutritional properties, but it did give an effect on sensory qualities with the method of hedonic rating test, hedonic quality, and quantitative descriptive analysis. However, the formulations require to be improved in several attributes based on the results of quantitative descriptive analysis data, such as the bitter taste.

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