

# Suitability of Purple-Fleshed Sweet Potato Clones for Ingredients of Chinese Buns (Buns)

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**Abstract.** Sweet potato is a type of tuber that is a source of carbohydrates, vitamins, minerals and dietary fiber as well as bioactive components. The presence of anthocyanins in purple-fleshed sweet potato has been intensively promoted as functional foods. Characteristics of 3 varieties and 2 clones of sweet potato used as raw material for buns have different texture characteristics. The textures of RIS 10043-02 and MSU 10003-07 had higher hardness, cohesiveness and chewiness compared to the other 3 varieties. The high chewiness value of the buns made from Antin 2 (257.52N) was due to the high value of hardness (5.78N), springiness (73.77%) and cohesiveness (0.63N). The higher the anthocyanin content in the raw material, the lower the L\*, a\* and b\* values of buns produced, moreover, the high the color preferences of the panelist. The score given by the panelists ranged from 3.64 to 4.08 for the 4 sensory criterias of buns made of 5 sweet potato clones. It appears that the panelists liked the buns made from the MSU 10003-07 clone followed by Antin 2 and Antin 3.

Keywords: *Sweet potato, buns, physical, chemical*

## I. INTRODUCTION

Sweet potato is a type of tuber that is a source of carbohydrates, vitamins, minerals and dietary fiber as well as bioactive components, such as beta carotene, anthocyanins, and phenolic compounds that are beneficial to human health [1]. Sweet potato whose tubers have a purple color, it was found that the main component that makes up the color is anthocyanin [2]. Consumption of anthocyanins is associated with reduced risk of cardiovascular and degenerative metabolic diseases, visual and brain function improvement, cancer chemoprevention, anti-inflammatory, hepatoprotective and antihyperglycemic activities even when bioavailability is low [3], [4], [5].

Table 1. Chemical composition of 3 purple sweet potato varieties

| Varieties | Total sugar (%) | Starch (%) | Anthocyanine (mg/100g) | Dry Matter (%) |
|-----------|-----------------|------------|------------------------|----------------|
| Antin 1   | 1.7             | 19.3       | 7.8                    | 33.5           |
| Antin 2   | 0.4             | 22.2       | 130.2                  | 32.6           |
| Antin 3   | 0.9             | 18.2       | 150.7                  | 31.3           |

source: <https://new.litbang.pertanian.go.id/info-teknologi/2648/>

The high anthocyanin content of purple sweet potato is important in its use as a food colorant because of its higher stability against heating and UV irradiation compared to anthocyanins from strawberries, raspberries, apples and black soybeans. [6], [7], [8]. They degrade only partially when subjected to heating [9] and have been used in industrialized foodstuffs such as

juices, alcoholic beverages, pasta, flour, breads and others as natural dye and antioxidant [8]. Since acylated anthocyanins have higher processing stability, bioprotective capacity and resistance to overall simulated digestions than non-acylated anthocyanins they are desirable for their provision of color and health benefits [10], [11], [12].

Promotion of health benefits and the availability of a variety of alternative food products from sweet potato would help to increase the consumption as well as the health status of the community and support the local food diversification program. In general, traditional food products from sweet potatoes are considered less attractive than those from wheat flour, so it is necessary to develop a food product and introduce it to both processors and consumers. Sweet potato has the potential to be used as a partial substitute for wheat flour in flour-based products, especially bread and flour products. Promotion of the health benefits and availability of various alternative food products from sweet potato will help increase consumption and public health status and support local food diversification programs.

Currently, three varieties of purple sweet potato have been released, namely Antin 1 (purple white), Antin 2 (purple red), and Antin 3 (dark purple) (Table 1). In addition, there are also two promising sweet potato lines with yield potentials exceeding 35 t/ha, with different purple color intensities as a result of a series of breeding activities (RIS 10043-02 and MSU 10003-07). Before being released as a new variety, the clones need to be evaluated to determine its suitability for food products so that it can be accepted by users. In this study, 3 varieties and 2 clones of purple sweet potato with purple flesh were used as a substitute for wheat flour for making buns and evaluated the suitability of their physical and sensory attributes. The selection of purple sweet potato as a substitute material is intended to increase the use of sweet potato as a substitute material in an effort to reduce the need for flour as well as to increase the anthocyanin content in the final product.

## **2. METHODOLOGY**

Five purple-fleshed sweet potato consists of three varieties (Antin 1, Antin 2 and Antin 3), and two promising lines namely RIS 10043-02 and MSU 10003-07 were harvested after 4-4.5-month planting in Tumpang, Malang.

The fresh tubers were washed, steamed for 30 min, peeled and mashed then processed into mashed sweet potato. Mashed sweet potato were observed for their moisture, reducing sugar, anthocyanin content, and the Hunter colors ( $L^*$ ,  $a^*$ ,  $b^*$ ) in the Food Chemistry Laboratory of Indonesian Legumes and Tuber Crops Research Institute (Iletri), Malang. Texture Profile Characteristics was also determined using TPA method using Texture analyzer. Next, mashed sweet potato is mixed with wheat flour with an amount of 30% of the total dough, dried yeast, improver, salad and water. For the buns, characteristics were also analyzed including moisture content, development of dough, yield recovery, porosity, colors, and also texture profile characteristics. Organoleptics attributes (color, aroma, taste and texture ) were conducted using a Hedonic test by 25 panelists. A randomized complete design was applied for the trial with five replicates. Data was analyzed using ANOVA and followed by an LSD test at 5% level to obtain the differences between the materials tested.

## **3. RESULT AND DISCUSSION**

### **3.1. Texture profile characteristic steamed sweet potato tubers**

The texture profile characteristic is an important attribute in steamed sweet potatoes, because it shows the texture properties when the tubers are subjected to the heating process. Each clone has different texture properties. In the current breeding system in Japan, the textural characteristics are divided into five categories: mealy, slightly mealy, intermediate, slightly soggy, and soggy [13]. Differences in texture characteristics will cause differences in the properties of the product when it is continued with further processing.

Hardness is a mechanical parameter in the form of a given force to achieve deformation. The results showed that the hardness values were significantly different between sweet potato clones (Table 2). The RIS 10043-02 clone had the highest hardness value, followed by Antin 3 which was not significantly different from Antin 2, and Antin 1 the lowest. The difference in hardness is caused by differences in moisture, the higher the water content generally causes the lower the hardness. However, the presence of other components can also affect the hardness, clone RIS 10043-02 has a high level of hardness. This can be caused by the presence of fiber [14].

Table 2. Texture profile characteristics of 5 sweet potato varieties/klon

| Varieties/clones | Hardness<br>(N) | Adhesiveness<br>(N) | Springiness<br>(%) | Cohesiveness<br>(N) | Chewiness<br>(N) |
|------------------|-----------------|---------------------|--------------------|---------------------|------------------|
| Antin 1          | 3.73 d          | 0.07 ns             | 57.28 ns           | 0.08 bc             | 15.67 b          |
| Antin 2          | 4.90 c          | 0.06                | 79.17              | 0.09 abc            | 36.02 ab         |
| Antin 3          | 5.44 bc         | 0.08                | 68.17              | 0.06 c              | 22.46 ab         |
| RIS 10043-02     | 6.73 a          | 0.02                | 72.90              | 0.12 ab             | 62.15 a          |
| MSU 10003-07     | 5.88 b          | 0.06                | 75.33              | 0.14 a              | 62.12 a          |
| Cv (%)           | 6.03            | 136.62              | 24.57              | 36.88               | 54.80            |
| LSD value        | 0.60            | -                   | -                  | 0.06                | 40.94            |

Numbers in the same column followed by the different letters are significantly different at 5% of the LSD test

Note: L \*: Lightness level from a dark range (0) to light (100)

a \*: green (−100) to red (+100)

b \*: blue (−100) to yellow (+100)

Adhesiveness is the force required to overcome the attractive forces between the food surface and the surface of other materials. The adhesiveness of the materials was not significantly different between sweet potato clones with a range of 0.02 to 0.08 N. The adhesiveness value of steamed purple sweet potato obtained was low. The ability of amylose to bind a lot of water causes the steamed sweet potato to have a harder texture or lower stickiness [15]. Steaming can increase the adhesiveness value of tubers, because the gelatinized starch forms a gel which can increase its viscosity [16].

Springiness relates to “how well a product springs back after it has been deformed or to its un-deformed condition after the deforming force is removed”, which indicates the elasticity of the product [17], [18]. The springiness values of the five purple sweet potato clones were not significantly different with a range of 57.28% to 79.18%. High moisture content in the material causes a decrease in the value of springiness or loss of elasticity. A high springiness value indicates that the texture is more elastic [19].

Cohesiveness is defined as the degree to which a material can deform before breaking. The results showed that the cohesiveness was significantly different between the sweet potato clones in the range of 0.06 -0.14 (Table 2). The highest cohesiveness value was found in the

MSU 10003-07 clone which was not significantly different from RIS 10043-02 and Antin 2. Meanwhile, Antin 3 was not significantly different from Antin 1 and Antin 2.

Chewiness is the energy needed to break down solid food to a state ready to be swallowed [20]. The results showed that the chewiness value was significantly different with a range between 15,673 - 62,15 N (Table 2). The clones of RIS 10043-02, MSU 10003-07, and Antin 2 had the highest chewiness values and were not significantly different; while Antin 1, Antin 2, and Antin 3 have chewiness values that are not significantly different. Chewiness value is related to hardness [21]. The hardness value of RIS 10043-02 is quite high, so the chewiness of the genotype is also high. This also happened to Antin 1, where the genotype had a low hardness value, so chewiness was also low. In addition, the observation also shows that chewiness is also influenced by springiness and cohesiveness.

### 3.2. The characteristics of mashed sweet potato

Moisture content in sweet potato paste is an important component as a determinant of quality in further processed products. Based on Table 3, the moisture content of the Antin 1 had the lowest value and was followed by Antin 2 and 3 and then followed by 2 clones tested. The moisture content of sweet potatoes after steaming can decrease compared to fresh tubers. This occurs due to the evaporation process during the gelatinization process [22], [23]. However, the difference that occurs is quite narrow in value between the 5 varieties used as raw material for Buns.

Tabel 3. Moisture, reducing sugar, anthocyanin content and color attributes of mashed sweet potato

| Varieties/clones | Moisture (%) | Reducing sugar (%) | Anthocyanin (mg/100g) | L* (%)  | a*      | b*     |
|------------------|--------------|--------------------|-----------------------|---------|---------|--------|
| Antin 1          | 69.57 c      | 13.28 e            | 8.54 d                | 42.20 a | 35.33 a | 6.70 c |
| Antin 2          | 67.39 d      | 19.99 a            | 100.11 c              | 28.93 c | 25.33 b | 6.20 d |
| Antin 3          | 67.50 d      | 18.25 c            | 150.91 a              | 30.43 b | 25.23 b | 7.03 c |
| RIS 10043-02     | 71.68 a      | 18.76 b            | 105.41 c              | 26.10 d | 23.53 c | 8.00 b |
| MSU 10003-07     | 70.23 b      | 15.64 d            | 118.48 b              | 29.13 e | 23.93 c | 8.90 a |
| Cv (%)           | 0.28         | 1.22               | 3.77                  | 1.31    | 1.88    | 2.47   |
| LSD value        | 0.37         | 0.39               | 6.87                  | 0.77    | 0.94    | 0.34   |

Values in the same column followed by the same letters are not significantly different ( $P < 0.05$ )

L\*: Lightness level that ranges from 0 (dark/black) to 100 (light/white)

a\*: Redness level that ranges from green (−100) up to red (+100)

b\*: Yellowness level that ranges from blue (−100) up to yellow (+100)

The reducing sugar in mashed sweet potatoes is generally quite high compared to fresh tubers. The reducing sugars, particularly maltose, levels of sweet potato root can also be attributed to the hydrolytic ability of native amylases present in the uncooked roots. Sweet potato roots contain high levels of amylases, mainly  $\alpha$ - and  $\beta$ -amylase, which significantly influence levels of sugar in processed sweet potatoes [24]. Steaming treatment resulted in an increase in maltose content in all the varieties. On the contrary, it caused a reduction in sucrose content in all the varieties compared to the raw roots [25]. The levels of reducing sugar contained in 5 mashed sweet potatoes were sequentially from the highest, namely Antin 2, RIS 10043-02, Antin 3, MSU 10003-07 and the lowest was Antin 1.

Anthocyanin levels of mashed purple sweet potato were significantly different between sweet potato clones while the highest value found in Antin 3 150.91 g/100 g (%wb) and the lowest

was Antin 1 (8.54 mg/100 g (%wb), whereas 3 others have moderate levels of anthocyanins contents. Changes in anthocyanins content can be caused by a continuous heating process at high temperatures for a long time; this causes dissociation of the anthocyanin co-pigment complex [26] and causes changes in the stability of anthocyanins to a colorless form.

For the color attributes of mashed sweet potato, Lightness value (L\*) was significantly different with the highest value in the Antin 1 (42.20%), while the lowest was RIS 10043-02 (26.10 %). Another color parameter, namely redness, the highest level of redness (a\*) was found in Antin 1, followed by Antin 2 and Antin 3 which were not significantly different and the lowest was RIS 10043-02 and MSU 10003-07 which were not significantly different either. The color attribute of mashed sweet potato is affected by the anthocyanin content. The higher the anthocyanin content, the lower the L\* and a\* values of mashed sweet potato.

### 3.3. The physical and organoleptic attributes of sweet potato buns

Buns made from five raw materials have been tested for their physical properties. Table 4 presents the results in the form of moisture content and physical properties of the resulting buns. Buns made from Antin 1 and Antin 2 had a lower moisture content than the bun made from Antin 3, and MSU 10003-07. This is in line with the moisture content of the mashed sweet potato used. The greater the moisture contents of the raw material, the greater the moisture content of the product. However, this is not in line with the yield of the buns produced. Yield is the change in weight of the dough before steaming and after steaming. The highest yield was obtained in the buns made from Antin 3 which had the highest moisture content of the buns, this could be due to the high amount of water in the product.

Table 4. Moisture content and physical properties of buns

| Varieties/clones | Moisture (%) | Yield (%) | Development (%) | Pores/cm <sup>2</sup> |
|------------------|--------------|-----------|-----------------|-----------------------|
| Antin 1          | 34.66 c      | 101.0 b   | 137.7 a         | 64.40 d               |
| Antin 2          | 36.60 b      | 102.0 b   | 111.8 c         | 83.40 b               |
| Antin 3          | 38.10 a      | 102.9 a   | 112.1 c         | 99.40 a               |
| RIS 10043-02     | 37.77 a      | 101.4 b   | 121.7 b         | 76.20 c               |
| MSU 10003-07     | 37.72 a      | 93.4 c    | 116.7 bc        | 98.20 a               |
| Cv (%)           | 1.47         | 0.46      | 5.63            | 5.03                  |
| LSD value        | 1.02         | 0.62      | 9.07            | 5.69                  |

Values in the same column followed by the same letters are not significantly different (P< 0.05)

Based on the volume of development, Antin 1 produces buns with the highest development value of 137.7%, while the others are relatively uniform. Development is the process of expanding the volume of the dough from the beginning of the mixing process to steaming. Development occurs due to the fermentation process caused by the production of CO<sub>2</sub> by yeast activity. The pores/cm<sup>2</sup> indicates the number of pores in the buns. The high number of pores is owned by buns made from Antin 3 and MSU 10003-07, while the lowest is in Antin 1. The number of pores does not seem to be in line with the development value. This is due to the difference in the size of the pores in the tissue in the bun. Buns made from Antin 1 had the lowest number of pores, followed by buns made from RIS 10043-02. This was due to the fact that the pores on the two buns had a larger size due to the high development during fermentation, compared to the buns from the other clones.

Color is an important property that will be detected visually by consumers. The color of the buns made from 3 varieties and 2 clones of purple sweet potato is a product that needs to be

studied and developed based on the purple color of the buns obtained. The color criteria for the resulting buns were tested based on the level of Lightness (L), redness (a\*) and yellowness (b\*) elements.

Table 5. Color properties of buns

| Varieties/clones | Lightness (%) | a*       | b*      |
|------------------|---------------|----------|---------|
| Antin 1          | 57.74 a       | 39.50 a  | 20.34 a |
| Antin 2          | 43.22 b       | 34.44 bc | 10.48 c |
| Antin 3          | 39.88 c       | 33.08 cd | 8.40 d  |
| RIS 10043-02     | 42.78 b       | 31.98 d  | 14.14 b |
| MSU 10003-07     | 42.00 bc      | 36.08 b  | 10.18 c |
| Cv (%)           | 4.63          | 3.78     | 3.22    |
| LSD value        | 2.80          | 1.78     | 0.54    |

Values in the same column followed by the same letters are not significantly different ( $P < 0.05$ )

L\*: Lightness level that ranges from 0 (dark/black) to 100 (light/white)

a\*: Redness level that ranges from green (−100) up to red (+100)

b\*: Yellowness level that ranges from blue (−100) up to yellow (+100)

Table 5 shows the color properties of buns made from purple sweet potatoes. The bun made from Antin 3 has a low L\* with a medium a\* and a low b\*, visually it looks a darker purple color compared to the other four buns. While, the buns made from RIS 10043-02 and MSU 10003-07 have a purple color with a medium brightness level. Buns made from Antin 1 has the highest L\*, a\* and b\*, this is because it is made from Antin 1 sweet potato which has a low intensity of purple color. As with the color attribute of mashed sweet potato, the color of the buns produced is also significantly negative correlated of the anthocyanin content in the mashed sweet potato used. The higher the anthocyanin content, the lower the L\*, a\* and b\* values of buns produced.

Table 6. Texture profile characteristic of buns made from 5 sweet potato varieties/clones

| Varieties/clones | Hardness<br>(N) | Adhesiveness<br>(N) | Springiness<br>(%) | Cohesiveness<br>(N) | Chewiness<br>(N) |
|------------------|-----------------|---------------------|--------------------|---------------------|------------------|
| Antin 1          | 3.70 ns         | 0.03 ns             | 60.96 ns           | 0.55 ns             | 127.5 b          |
| Antin 2          | 5.78            | 0.02                | 73.77              | 0.63                | 257.5 a          |
| Antin 3          | 5.81            | 0.01                | 59.14              | 0.49                | 160.8 b          |
| RIS 10043-02     | 3.79            | 0.04                | 59.86              | 0.61                | 137.2 b          |
| MSU 10003-07     | 4.83            | 0.04                | 55.75              | 0.50                | 140.5 b          |
| Cv (%)           | 32.09           | 92.12               | 18.15              | 21.77               | 38.64            |
| LSD value        | -               | -                   | -                  | -                   | 85.32            |

Values in the same column followed by the same letters are not significantly different ( $P < 0.05$ )

The texture profile attributes of a product are the physical characteristics possessed by a product. The texture profile components tested were hardness, adhesiveness, springiness, cohesiveness and chewiness. The results of texture testing on buns made from five types of purple sweet potato are presented in table 6. The tested buns had hardness, adhesiveness, springiness and cohesiveness that were not significantly different. This indicated that the physical characteristics of the five buns were uniform even though they were made by substitution from 5 sweet potato clones. However, the chewiness values of the five buns were found to be significantly different. Buns made from Antin 2 have the highest chewiness value compared to others. Chewiness value is strongly influenced by other texture attributes such as

hardness, springiness and cohesiveness, the higher the value, the higher the chewiness value. The high chewiness value of the bun made from Antin 2 (257.52N) was due to the high value of hardness (5.78N), springiness (73.77%) and cohesiveness (0.63N).

Table 7. sensory preferences of buns

| Varieties/clones | Color preferences | Aroma preferences | Taste preferences | Texture |
|------------------|-------------------|-------------------|-------------------|---------|
| Antin 1          | 2.16 c            | 3.40 b            | 3.76 ab           | 3.72 b  |
| Antin 2          | 3.64 ab           | 3.76 ab           | 3.84 ab           | 3.96 ab |
| Antin 3          | 3.88 a            | 3.64 ab           | 3.80 ab           | 3.88 ab |
| RIS 10043-02     | 3.40 b            | 3.72 ab           | 3.48 b            | 3.64 b  |
| MSU 10003-07     | 3.92 a            | 3.90 a            | 4.12 a            | 4.08 a  |
| Cv (%)           | 21.65             | 19.03             | 19.52             | 15.44   |
| LSD value        | 0.41              | 0.39              | 0.42              | 0.33    |

Scores of preferences for colour, taste and texture:

1. Strongly dislike
2. Moderately dislike
3. Slightly like
4. Moderately Like
5. Strongly like

The panelist's color preference of the buns ranged from 2.16 to 3.92, which mean that it ranges from slightly to moderately liked. The color of buns made from Antin 1 had the lowest preference, this could be because the buns had a dark purple color with an indication of high  $L^*$ ,  $a^*$  and  $b^*$ . Buns made of Antin 2, Antin 3 and MSU 10003-07 have a high level of panelist preference value; this is due to the light purple color as shown by the color attributes of buns. Panelists' preferences for color has a negative correlation with the value of  $L^*$ ,  $a^*$  and  $b^*$  buns. For aroma and taste, the panelists did not expressly indicate the difference in preference for buns made of 5 clones of sweet potato. This can be seen from the preference value which is in the range of 3.4 to 3.9 for the aroma of the tested buns, while for the taste is ranged for 3.48 to 4.12. The aroma and taste of the buns did not appear to be influenced by the sweet potato clones, but by the ingredients used to make the buns which were added in the same amount.

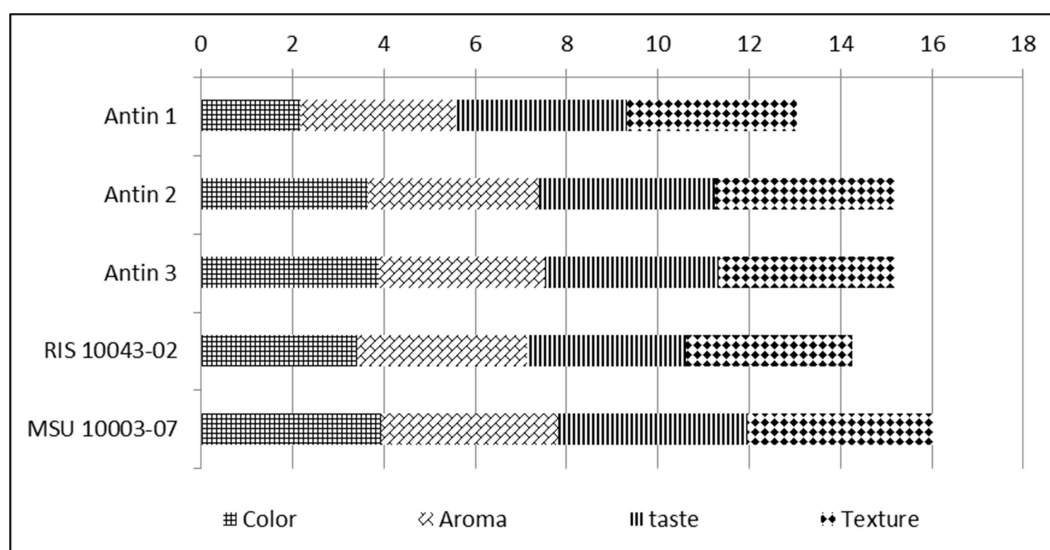


Fig 1. Histogram total of sensory attributes that given by panelist.

Texture is the sensory attribute that reflects the strength of the energy required to chew food. The panelists also didn't seem to express their preference for the texture of the buns made from 5 sweet potato clones. The score given by the panelists ranged from 3.64 to 4.08. Based on the organoleptic test on 4 criteria carried out on buns made of 5 sweet potato clones, it appears that the panelists liked the buns made from the MSU 10003-07 clone followed by Antin 2 and Antin 3. Buns made from RIS 10043-02 and Antin 1 has a preference score that is below all three (Fig 1).

#### 4. CONCLUSION

Characteristics of 3 varieties and 2 clones of sweet potato used as raw material for buns have different texture characteristics. The textures of RIS 10043-02 and MSU 10003-07 had higher hardness, cohesiveness and chewiness compared to the other 3 varieties. However, these differences do not affect the yield, development and pores parameters of buns.

Chewiness in buns has an important role in buns, because it indicates the level of energy required to chew the product. Chewiness buns were found to differ between the raw materials used. The high chewiness value of the bun made from Antin 2 (257.52N) was due to the high value of hardness (5.78N), springiness (73.77%) and cohesiveness (0.63N).

Anthocyanin levels in tubers play a very important role in determining the color of mashed tubers and also on the color of buns. The higher the anthocyanin content in the raw material, the lower the lightness level and the purple color level. As with the color attribute of mashed sweet potato, the color of the buns produced is also significantly negative correlated of the anthocyanin content in the mashed sweet potato used. The higher the anthocyanin content, the lower the L\*, a\* and b\* values of buns produced. Moreover, the lower the L\*, a\* and b\* values of buns, the high the color preferences of the panelist.

The score given by the panelists ranged from 3.64 to 4.08. Based on the organoleptic test on 4 criteria carried out on buns made of 5 sweet potato clones, it appears that the panelists liked the buns made from the MSU 10003-07 clone followed by Antin 2 and Antin 3. Buns made from RIS 10043-02 and Antin 1 has a preference score that is below all three

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