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ANTIOXIDANT ACTIVITY OF GUMMY CANDIES OF PURPLE NUTSEDGE TUBER (*Cyperus rotundus* L.) AND CINNAMON (*Cinnamomum burmannii Nees ex & T. Nees* Blume.) EXTRACTS

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ABSTRACT

Along with the development era, health is increasingly being considered. One of the things that is currently being discussed is functional food containing antioxidant compound that can inhibited free radical that cause cardiovascular disease from plant extracts. One of the plants that contains antioxidants is purple nutsedge tuber (*Cyperus rotundus* L.). Gummy candies have characteristics with a dense and chewy gel texture. The combination with cinnamon (*Cinnamomum burmannii* Nees ex & T. Nees Blume) is done to increase the antioxidant value. This study aims to determine the antioxidant activity in gummy candies, which are produced using a combination of purple nutsedge tuber and cinnamon extracts. This study employed a quantitative-descriptive methodology. The formulation of the gummy candies was prepared with a ratio of purple nutsedge tubers to cinnamon, F1(15:5%), F2(10:10%), and F3(5:15%). The organoleptic of the gummy candies were a dark brown color, a distinctive aroma associated with purple nutsedge tubers, sweet and astringency, and a chewy texture. The moisture content of the gummy candies in the F0-F3 were 12.430-15.593% and the ash content were 0.131-0.265%. Both parameters which met the requirements of SNI 3547.2:2008. The antioxidant activity of the purple nutsedge tuber extract was 65.675 ppm, while the cinnamon extract was 44.883 ppm. The antioxidant activity on gummy candies from F0-F3 with IC_{50}, respectively, amounted to 176.046 ppm, 121.184 ppm, 84.178 ppm, and 73.145 ppm, with weak to strong categories. It was observed that as the quantity of cinnamon extract incorporated into the formulation increased, the antioxidant activity also increased.

Keywords: Gummy candies, purple nutsedge tuber, cinnamon extract, and antioxidant

INTRODUCTION

Indonesia is rich in natural resources and boasts fertile soil that supports a vast array of biodiversity. Among these, the purple nutsedge tuber (*Cyperus rotundus L.*) stands out for its health benefits, particularly its tubers. These tubers are rich in alkaloids, tannins, and flavonoids, which function as antioxidants, anti-inflammatory agents, and antidiabetic compounds (Pradana, 2014). Meanwhile, gummy candies have gained widespread popularity across all age groups due to their vibrant appearance, pleasant aroma, appealing taste, and unique shape (Juliantoni *et al.*, 2018).

Gummy candies, as a type of nutraceutical product, are known to contain antioxidants-compounds capable of neutralizing free radicals. Free radicals, when entering the body, can attack healthy cells, resulting in their inactivation and loss of structural function (Hasti & Makbul, 2022). Research Anandea, (2018) has classified the antioxidant activity of purple nutsedge tubers as potent, with an IC_{50} value of 62.82 ppm.

Additionally, cinnamon (*Cinnamomum burmannii Nees ex & T. Nees* BIume.) is commonly utilized in the production of gummy candies. Research has shown that cinnamon exhibits potent antioxidant activity, with an IC_{50} value of 19.79 ppm (Hasti & Makbul, 2022). Beyond its role as a natural antioxidant, cinnamon also contributes a fresh aroma, enhancing both the sensory appeal and potential market value of gummy candies. When combined with purple nutsedge tuber (*Cyperus rotundus* L.) extract, cinnamon has the potential to further boost the antioxidant properties and commercial appeal of gummy candies products (Sulfiana & Harlia, 2014).

The quality of the gummy candies is assessed through a series of tests. The tests conducted are organoleptic, moisture and ash content analyses, which are employed to evaluate the quality of gummy candies and ascertain their alignment with established standards. One of the methods used for antioxidant testing is the DPPH method.

METHODS

This study employs a quantitative research methodology to determine specific components in a substance by collecting measured data. This quantitative study aims to measure and determine the moisture and ash contents of gummy candies containing purple nutsedge tuber (*Cyperus rotundus* L.) and cinnamon (*Cinnamomum burmannii Nees ex & T. Nees* BIume.) extracts, as well as to determine the antioxidant levels present.

Instrument

The finstruments were used in this research were hotplate, 80-mesh sieve, blender, light-resistant bottle, water bath, analytical balance (*Labex*), oven (*Memmert*), silicone mold, mortar and pestle, furnace, beaker glass, measuring cup, measuring flask, stirring rod, test tube, pipette, aluminum foil, porcelain cup, silicate crucible, cuvette, and UV-Vis spectrophotometer (*Inova*).

Materials

The materials used in this study were purple nutsedge tubers, dried cinnamon, gelatin, propylene glycol, sucralose, citric acid, distilled water, 70% ethanol, ethanol p.a. (*Emsure*), quercetin (*Sigma Aldrich*), Whatman 41 filter paper, and 2,2-diphenyl-2-picrylhydrazyl (DPPH) (*Sigma Aldrich*).

Methods

The raw material for purple nutsedge tubers was obtained from the rice fields of Bendosari Village, Sawit District, Boyolali while dried cinnamon was obtained from *UPF Pelayanan Kesehatan Tradisional Tawangmangu RSUP Dr. Sardjito.*

The research stages incude extract making, the production of gummy candies, the physical quality assay, and antioxidant activity also analysis the data collected.

Extraction of purple nutsedge tubers and cinnamon

A 300 g of purple nutsedge tubers and cinnamon powder are each put into a maceration vessel plus 3000 mL of 70% ethanol solvent is added while stirring until evenly moistened. Extraction is carried out for 3x24 hours (Anandea, 2018). The macerate of purple nutsedge tubers (*Cyperus rotundus* L.) and cinnamon (*Cinnamomum burmannii Nees ex & T. Nees* BIume.) are evaporated at a temperature of 78.15 ^{o}C for 4 hours to minimize the 70% ethanol content in purple nutsedge tubers and cinnamon extract (Oktavianingsih *et al*., 2018; Ramdlani, 2022).

Formulation gummy candies

Table 1. Formulation of Gummy Candies

Materials	F0	F1	F2	F3
Purple nutsedge tuber extract	0	15	10	5
Cinnamon extract	0	5	10	15
Gelatine	25	25	25	25
Propilenglicol	10	10	10	10
Sucralose	1	1	1	1
citric acid	0,3	0,3	0,3	0,3
Aquadest	add 100	add 100	add 100	add 100

The preparation is conducted by developing gelatin in warm distilled water at a temperature of ±40 ^{o}C, left for ±10 minutes until the gelatin expands to form a gel, dissolved the extract of nutsedge and cinnamon into propylene glycol (solution A). Sucralose and citric acid are dissolved in distilled water (solution B). Solutions A and B are mixed, stirred until homogeneous (solution C). Heat the gelatin on a hotplate in a beaker at a temperature of ±40-50 ^{o}C for 5 minutes until it melts. Solution C is poured into a beaker while stirring until homogeneous. The formula is lifted from the hotplate and poured into a gummy candies mold. Leave the gummy candies formula for 2 x 24 hours at room temperature (15-30 ^{o}C) until the formula solidifies and can be removed from the mold (Amaria *et al.*, 2019).

Phisycal quality of gummy candies

A series of physical quality tests including organoleptics (Gusnadi *et al.,* 2021), moisture content (Yulia *et al.*, 2022) and ash content (Sunartaty &Yulia, 2017) were conducted on gummy candies.

Antioxidant activity of gummy candies

Antioxidant activity assay refers to (Souhoka *et al.*, 2019; Rasyadi *et al.*, 2022). Firstly, the test carried out by piping a number of extract sample stock 1000 mg/L in ethanol into 10, 20, 50, 70, and 90 mg/L concentration. Later, from stock solution gummy candies 1000 mg/L in ethanol was made into series solution 50, 100, 150, 200, and 250 mg/L. To determine the antioxidant activity from extract and sample by piping 2 mL of the solutions and added 2 mL of DPPH 50 mg/L. The solution is allowed to stand for 30 minutes at room temperature. The absorbance of solution was measured with a UV-Vis Spectrophotometer at wavelength of 517 nm. The same treatment for series quercetin standard solution of 2, 4, 6, 8, and 8 mg/L. Absorbance of solution was calculated by %inhibition.

$$\%\ \text{Inhibisi} = \frac{\text{Abs control} - \text{Abs sample}}{\text{Abs control}}\ \text{x}\ 100\%$$

Antioxidant activity is determined from the IC_{50} value. The IC_{50} value is a number that indicates the concentration of the test sample that provides immersion of 50% (able to inhibit or soak the oxidation process by 50%). The value of IC_{50} is determined by making a linear curve between the concentration of the test solution (x-axis) and % inhibition (y-axis) so that the equation y = bx + a where y is % inhibition, x is the value of IC_{50}, b is slope and a is intercept.

$$IC_{50} = \frac{50 - a}{b}$$

The data analysis in this study is based on univariate analysis to describe the frequency distribution of each variable. The findings of this study will be presented in the form of narratives and tables.

RESULT AND DISCUSSION

Plant determination

Purple nutsedge tubers obtained from Bendosari Village, Sawit District, Boyolali, and dried cinnamon from *UPF Pelayanan Kesehatan Tradisional Tawangmangu RSUP Dr. Sardjito.* Both were determined in *UPF Pelayanan Kesehatan Tradisional Tawangmangu RSUP Dr. Sardjito*. The determination result of fresh purple nutsedge tuber samples belongs to the species *Cyperus rotundus* L., and dried cinnamon samples belong to the species *Cinnamomum burmannii* (Nees & T. Ness) Blume.

Extract yield

Subsequently, the powdered purple nutsedge tubers and cinnamons that have been extracted through maceration are evaporated by a water bath at 50 °C, resulting in a thick extract. The yield results obtained are presented in Table 1.

Table 2. Extract Yield of Purple Nutsedge Tubers And Cinnamons

Materials	Raw weight (g)	Extract weight (g)	Yield (%)
Dried purple nutsedge tubers	300	52.58	17.52
Dried cinnamon	300	81.11	27.03

The yield obtained from the purple nutsedge tubers was 17.52%, with a total extract yield of 52.58 g. The resulting yield is comparatively less than that observed in the previous research Nurjanah *et al.* (2018), where the yield was recorded at 18.50%. The thick extract obtained from cinnamon amounted to 81.11 g, resulting in a yield of 27.03%. The obtained yield surpasses the findings of the study Nurani *et al.*, (2021), which yielded 26.66%. The yield value was collected its diffrenet from previous research because its can be influenced by several factors, namely the type of solvent polarity, the size of the simplicia, the concentration of the solvent used and the length of extraction time. Apart from that, something that can be a factor in the small yield is the sampling extract. Different sampling can also produce different secondary metabolite compounds (Sineke *et al.*, 2016).

Organoleptic Tests

The objective of this test is to examine the sensory properties of gummy candies, specifically in terms of color, odor, taste, and texture. The results are presented in Table 3.

Table 3. The Organoleptics of Gummy Candies of Purple Nutsedge Tuber and Cinnamon

Formula	Color	Odor	Taste	Texture
F0	Transparent yellow	Gelatin-like	Sweet and slightly sour	Chewy
F1	Dark brown	Purple nutsedge tubers-like	Sweet and slightly adstringent	Chewy
F2	Dark brown	Purple nutsedge tubers-like	Sweet	Chewy
F3	Dark brown	Purple nutsedge tubers-like	Sweet	Chewy

F0 = Gummy candy without purple nutsedge tubers and cinnamon extract
F1 = Gummy candy with purple nutsedge tubers (15%) and cinnamon (5%) extract
F2 = Gummy candy with purple nutsedge tubers (10%) and cinnamon (10%) extract
F3 = Gummy candy with purple nutsedge tubers (5%) and cinnamon (15%) extract

The organoleptic results for the gummy candies exhibit a distinct yellow color and a characteristic gelatinous aroma. In F1, F2, and F3, a subtle purple nutsedge tuber aroma is present, accompanied by a sweet and astringent flavor profile in F1, a sweet taste in F2 and

F3, and a slightly sour sweetness in F0. The texture is chewy, similar to that of traditional gummy candies. The astringent taste observed in the F1 can be attributed to the presence of tannin compounds, a phenolic type of secondary metabolite in plants that has an astringent taste, in the purple nutsedge tubers (Karomatul *et al.*, 2022). This finding is aligned with the established standard that gummy candies are considered normal. The sweet taste observed in the F2 and F3 can be explained by the ability of sucralose and cinnamon to mask the astringent taste of purple nutsedge tuber extract (Maslahah & Nurhayati, 2023).

Moisture content test

The objective of this test is to ascertain the proportion of moisture present in gummy candies. This process is conducted until a consistent weight is achieved. The findings are presented in Table 4.

Table 4. The Results of Gummy Candy Moisture Content Test

Sample	Moisture content (%)				BSN Quality Parameter (2008)	Conclusion
	Rep 1	Rep 2	Rep 3	Average ± SD		
F0	15.969	15.625	15.186	15.593 ± 0.392	Max 20	Qualified
F1	15.143	14.683	14.273	14.699 ± 0.435	Max 20	Qualified
F2	13.414	13.360	12.916	13.230 ± 0.273	Max 20	Qualified
F3	12.838	12.434	12.020	12.430 ± 0.409	Max 20	Qualified

The moisture content of gummy candies based on Table 3 indicated that the average moisture content of gummy candies from F0 to F3 are 15.593 ± 0.392%, 14.699 ± 0.435%, 13.230 ± 0.273%, and 12.430 ± 0.409%, respectively. The moisture content of F1 is greater than that of F2 and F3, which can be correlated with the higher moisture content of the purple nutsedge tuber extract in comparison to the cinnamon extract. The moisture content of the purple nutsedge tuber extract has been determined to be 7.09% following research Rustiani *et al.* (2017), while the moisture content of the cinnamon extract is 4.44% as indicated in research Angraini & Yanti (2021). The lowest moisture content was found in F3 with a concentration of 5:15 grass root extract: cinnamon, while the highest water content was found in sample F0, namely gummy candies without the addition of extract. This is in accordance with Riyawan *et al.* (2015) because the more extracts used, the thicker the preparation will be and the amount of moisture content in the preparation will be less, which will affect the moisture content of the product. Based on the results, the factors that influence the moisture content results of a product include the sample particle size. This factor influence the accuracy of determining the water content Daud & Suriati (2015). The results of the analysis of the moisture content of gummy candies, a combination of purple nutsedge tuber and cinnamon extract, are said to have met the candy quality requirements in SNI 3547-2-2008, namely no more than 20%.

Ash content test

The objective of this test is to ascertain the proportion of minerals in gummy candies. The findings are presented in Table 5.

Table 5 The Results of Gummy Candy Ash Content Test

Sample	Ash content (%)				BSN Quality Parameter (2008)	Conclusion
	Rep 1	Rep 2	Rep 3	Average± SD		
F0	0.264	0.265	0.266	0.265 ± 0.001	Max 3.0	Qualified
F1	0.180	0.180	0.179	0.179 ± 0.000	Max 3.0	Qualified
F2	0.174	0.173	0.173	0.173 ± 0.000	Max 3.0	Qualified
F3	0.131	0.131	0.132	0.131 ± 0.000	Max 3.0	Qualified

As illustrated in Table 4, the average ash content of gummy candies from F0 to F3 was found to be 0.265 ± 0.001, 0.179 ± 0.000, 0.173 ± 0.000, and 0.131 ± 0.000%, respectively. The ash content of F1 is greater than that of F2 and F3 due to the presence of purple nutsedge tuber extract, which has a higher mineral content compared to cinnamon extract. Research Firmansyah (2014), the ash content of purple nutsedge tuber extract was found to be 5.79%, while research Salsabela, (2022) indicated that the ash content of cinnamon extract was 2.94%. The results of the analysis of the ash content of gummy candies using a combination of nutgrass and cinnamon extracts have met the quality requirements for ash content, meeting the quality requirements for ash content of soft candy in SNI 3547-2-2008, which is no more than 3%. This shows that the raw materials for gummy candies used and the nutgrass and cinnamon extracts have sufficient ash content for making gummy candies so that the ash content produced meets the quality requirements (Nelwa *et al.*, 2014).

Antioxidant activity

The results of the antioxidant activity analysis of the gummy candies are presented in Table 6.

Table 6 Antioxidant activity of Extract and Gummy candies

Sample	Antioxidant activity IC_{50} (ppm)				Antioxidant activity
	Rep 1	Rep 2	Rep 3	Average± SD	
Purple nutsedge tuber	64.147	66.174	66.705	65.675 ± 1.349	Potent
Cinnamon	44.653	44.760	45.237	44.883 ± 0.310	Remarkably potent
F0	177.521	175.606	175.012	176.046 ± 0.956	Weak
F1	120.378	122.118	121.056	121.184 ± 0.877	Moderate
F2	83.831	83.041	85.662	84.178 ± 1.344	Potent
F3	72.181	74.093	73.162	73.145 ± 0.956	Potent
Quercetin	9.397	9.268	9.291	9.318 ± 0.068	Remarkably potent

As demonstrated in Table 5, the average IC_{50} value of gummy candies from F0 to F3 is 176.046 ppm, 121.184 ppm, 84.178 ppm, and 73.145 ppm, respectively. The cause of the high and low levels of antioxidant activity is due to the addition of purple nutsedge tuber and cinnamon extracts. In F3, the antioxidant activity value is higher because the addition of cinnamon extract is greater than in F1 and F2. This is in accordance with the results of research that has been conducted on purple nutsedge tuber and cinnamon extracts (Anandea, 2018). These findings align with the results of prior research on purple nutsedge tuber and cinnamon extract. The IC_{50} value of the purple nutsedge tuber extract was 65.675 ppm, indicating a potent antioxidant activity within the range of 50-100 ppm. The results align with the findings of previous studies Anandea (2018), which reported an antioxidant activity of 62.82 ppm for purple nutsedge tuber extract. The IC_{50} value of cinnamon extract was 44.883 ppm, classified as remarkably potent (IC_{50} <50 ppm) as the results align with the findings of previous studies Latief *et al.* (2013) which reported an antioxidant activity of 49 ppm on cinnamon extract. The results indicate that the antioxidant activity of cinnamon extract is greater than purple nutsedge tuber extract.

CONCLUSION

The organoleptic characteristics of the gummy candies made from the combination of purple nutsedge tuber (*Cyperus rotundus* L.) and cinnamon (*Cinnamomum burmannii Nees ex & T. Nees* Blume) extract were that F0 observed to be transparent yellow, with a distinctive gelatin aroma, a slightly sour sweetness taste, and a chewy texture. The gummy candies of the F1, F2, and F3 were characterized by a dark brown color, a distinctive aroma derived from purple nutsedge tuber, and a chewy texture. The F1 gummy candies exhibit a sweet taste with

a slight astringency, while F2 and F3 similarly display a sweet taste. The moisture content of gummy candies F0-F3 was found 12.430-15.593% with ash content 0.131-0.265%.

The antioxidant activity of the gummy candies is demonstrated by the IC_{50} values, which were F0 of 176.046 ppm (weak), F1 of 121.184 ppm (moderate), F2 of 84.178 ppm (strong) , and F3 of 73.145 ppm (strong).

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