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Physicochemical and sensory evaluation of pumpkin-based instant porridge with mocaf and cowpea flour

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ABSTRACT

Functional food is currently a necessity along with the emergence of several degenerative diseases. These degenerative diseases, including coronary heart disease, diabetes, and hypercholesterolemia are the leading causes of death today. This study aims to produce instant porridge mixed with mocaf, pumpkin, and cowpea flour that is preferred by panelists and has the potential as a functional food. Instant porridge mixed with mocaf, pumpkin, and cowpea flour with variations; 1:1:1, 1:2:1, and 1:3:1. The drying temperature variations used were 130ºC, 140ºC, and150ºC. The resulting instant porridge was tested for physical properties including: bulk density, yield, water and oil absorption, water absorption index, and colour. The level of preference was tested based on: colour, aroma, taste, viscosity, and overall preference. The instant porridge most preferred by panelists was analyzed chemically: water content, ash, protein, fat, carbohydrate by different, phenol, beta carotene, and antioxidant activity. Among all the samples tested in this study, the instant porridge that was most preferred by the panelists was the 1:3:1 variation at a drying temperature of 130ºC, and has the potential to serve as a functional food.

Keywords: pumpkin, mocaf, instant porridge, antioxidant activity, β-carotene

INTRODUCTION

Instant porridge is a convenient and time-saving food that requires minimal preparation, making it an ideal choice for quick and easy-to-serve food. Instant porridge is a versatile food suitable for individuals of all ages. Making instant porridge is simple and efficient, with minimal steps required. There are several previous studies on instant porridge, such as instant porridge mixed with wheat and millet flour **[1]**, instant porridge mixed with cinnamon, pumpkin, and morrel barry extract **[2]**, instant porridge mixed with pumpkin and porang flour **[3]**, instant porridge with corn, sweet potato, and moringa leaf powder **[4]**.

Pumpkin (*Cucurbita moschata*) is one available fruit that grows well in Indonesia. It is rich in vitamins and antioxidants. Pumpkin is also a source of β-carotene, with a β-carotene content of pumpkin flesh of 210 µg/g **[5]**. In addition, fresh pumpkin flesh has a total phenol of 9.98 mg GAE/g, flavonoids of 7.11 mg QE/g, and antioxidant activity of 32.14% **[6]**. Pumpkin has several bioactive compounds that prevent diseases such as diabetes, cancer, and coronary heart disease **[7]**. Despite its numerous benefits, the use of pumpkin as a food product is still relatively limited.

Mocaf (modified cassava flour) is cassava flour that undergoes a fermentation process involving lactic acid bacteria. Mocaf has a higher fiber content than wheat flour **[8]**. Mocaf can be used as an alternative raw material in food production due to its high carbohydrate content **[9]**. One of the disadvantages of mocaf is its low protein content of 1.77% **[10]**. Mocaf substitution can increase cookies' protein and dietary fiber levels **[11]**. Although mocaf has excellent potential, its use in food products remains relatively limited.

Cowpea (*Vigna unguiculata*) is a type of local bean widely cultivated in Indonesia. Cowpea can affect food security and is a staple food in most developing countries **[12]**. Cowpea flour increases protein in yellow corn mixtures **[13]**. Cowpea flour can be used as a substitute for wheat flour, as much as 10% in bread formulations

[14]. Gluten-free muffins made with cowpea flour have the same sensory properties as wheat bread **[15]**. Modified cowpea flour is a highly digestible resistant starch as a functional food **[16]**. However, until now, the use of cowpeas for food has been limited.

This research is essential as it aims to develop instant porridge that is both appealing and functional, requiring the optimisation of ingredient ratios and the appropriate drying temperature. This study intends to produce instant porridge mixed with mocaf, pumpkin, and cowpea flour, which is accepted by panelists and serves as a functional food.

Scientific Hypothesis

The treatment of variations in mocaf, pumpkin and cowpea flour, and drying temperature is hypothesised to influence the instant porridge's physical, chemical, and preference levels.

Objectives

Primary objectives: This study aimed to formulate instant porridge mixed with mocaf, pumpkin, and cowpea flour, evaluate its physicochemical properties, and find the variation preferred by panelists that has the potential as a functional food.

MATERIAL AND METHODS

Samples

Samples description: This study involves nine mixed instant porridges with mocaf, pumpkin, and cowpea flour variations. Variations of the mixture of ingredients with formulations of 1:1:1, 1:2:1, and 1:3:1. Variations of drying temperatures used are 130°C, 140°C, and 150°C. This study's variations of mocaf, pumpkin, and cowpea flour are based on orientation results. The drying temperature is also based on the orientation results. Variations in materials and drying temperatures are variations that can produce instant porridge. Pumpkin was purchased at the local market Beringharjo Yogyakarta. Mocaf and cowpea flour were purchased from a local market in Yogyakarta. The pumpkins chosen for this study have the following characteristics: brown skin, orange flesh, and a weight range of 5 to 7 kg.

Samples collection: A total of 9 samples were made according to the instant porridge-making procedure. Each sample of 250 g was used to test the physical properties, preference levels, and chemical composition.

Samples preparation: Each sample was taken 50 g for physical properties testing, 150 g for sensory testing, and 50 g for chemical analysis.

Number of samples analysed: 9

Chemicals

Chemical materials for the analysis used Pro Analysis (PA) type were obtained from the Chemistry Laboratory at Universitas Mercu Buana Yogyakarta, Indonesia. The chemicals used include: catalyst, 95% petroleum benzene, 95% alcohol, H_2SO_4, 0.02N NCl, 0.02N HCl, methylene red, DPPH solution, 95% ethanol, Na Thio, BHT antioxidant, Na_2CO_3, boric acid, and folin-ciocalteu solution.

Animals, Plants and Biological Materials

This study used mocaf, pumpkin, and cowpea flour. No animals or biological materials were used in this study.

Instruments

The instruments used for physical tests, preference level tests, and chemical analysis are desiccators, UV-Vis spectrophotometry (Shimadzu), colorimeter, electric stove (Maspion), kjeldahl flask (Pyrex), soxhlet flask, centrifuge, centrifuge tube (Pyrex), micropipette, Erlenmeyer (Pyrex), test tube (Pyrex), test tube rack, measuring cup (Pyrex), burette, hyacinth pipette, cup, analytical balance (Ohaus), protein distillation apparatus, muffle (Thermolyne), oven (Memmert), and preference level test instruments.

Laboratory Methods

This study on producing instant porridge using different variations of mocaf, pumpkin, and cowpea flour, along with various drying temperatures, involved several stages of the process. The first stage is the process of making pumpkin porridge. Preparing pumpkin porridge begins with peeling the pumpkin, removing the seeds, cutting it into 2x2x2 cm^3 pieces, and then grinding it. The pumpkin pieces are weighed to 750 g and blended with 150 ml of distilled water. The pumpkin porridge is then used to make a mixture of instant porridge ingredients.

Variations of instant porridge consist of mocaf, pumpkin, and cowpea flour with variations of 1:1:1, 1:2:1, and 1:3:1. The mixture is then poured into a baking pan and flattened with a thickness of 0.5 cm. The following process is drying using an oven (getra) with temperature variations: 130℃, 140℃, and 150℃. The dry instant porridge (flake) is ground and sieved with a 60-mesh sieve.

The instant porridge is then subjected to physical tests of colour, rehydration, bulk density, water absorption capacity, oil absorption capacity, and yield. As semi-trained panelists, this study selected 36 Agricultural Product Technology Study Program students at Universitas Mercu Buana Yogyakarta, Indonesia.

The panelists were selected based on the following inclusion criteria: aged >18 years, like instant porridge, do not have any taste-related issues, and are not allergic to mocaf, pumpkin, and cowpea flour. Sensory test parameters of instant porridge consisted of colour, aroma, taste, viscosity, and overall.

The instant porridge that received the highest preference from the panelists was subsequently subjected to chemical analysis, including proximate analysis: water content, ash, protein, fat, and carbohydrate by difference **[17]**. An analysis of beta carotene **[18]**, total phenol [**19**], and antioxidant activity DPPH method (2,2-dyphenyl-l-1-picrylhydrazil) **[20]**. Chemical analysis and physical property testing were conducted in the chemistry laboratory and agricultural product processing laboratory of the Faculty of Agroindustry, Universitas Mercu Buana, Yogyakarta.

Description of the Experiment

Study flow: The research began with the preparation of mocaf, pumpkin, and cowpea flour. The ingredients are then made into instant porridge. The resulting instant porridge is then subjected to physical tests consisting of bulk density, yield, water absorption capacity, oil absorption capacity, and colour. Instant porridge was also tested for favorability using panellists. The most preferred instant porridge was analysed for moisture content, ash, protein, fat, and carbohydrates by differentiation, phenols, ß-carotene, and antioxidant activity.

Number of repeated analyses: 1

Number of experiment replication: 2

Amount of experiment replications: The experiment was conducted only once to determine a single value without any repetitions

Reference materials: -

Calibration: The calibration of the laboratory equipment was performed every six months, following established standards, to maintain accuracy and reliability in the measurement of this study.

Laboratory accreditation: The experiments were performed in the Laboratory of the Faculty of Agroindustry, Universitas Mercu Buana Yogyakarta accredited by the Indonesian National Accreditation Board for Higher Education (BAN-PT). Accreditation certification BAN-PT No. 5064/SK/BAN-PT/Akred/S/IX/2020.

Data Access

The data supporting this study are currently under an ongoing patent application and are available upon request from the corresponding author.

Statistical Analysis

The study used a completely randomized design with 2 factors. The research data consisted of physical and sensory properties were analyzed using SPSS version 25 general linear Univariate model with 95% significance. The chemical composition data were analyzed using descriptive statistics. The results of statistical tests needed are: mean, standard deviation, and differences between samples.

RESULTS AND DISCUSSION

Bulk density

The bulk density of the instant porridge produced is presented in Table 1.

Table 1 Bulk density of instant porridge with variations of mocaf, pumpkin, and cowpea flour (g/m^3).

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (℃)		
	130	140	150
1:1:1	0.76 ± 0.35^c	0.73 ± 0.01^c	0.68 ± 0.02^b
1:2:1	0.76 ± 0.01^c	0.73 ± 0.04^c	0.66 ± 0.01^{ab}
1:3:1	0.65 ± 0.02^{ab}	0.63 ± 0.02^a	0.63 ± 0.00^a

Note: Means labeled with the same letter display no statistically significant difference at the 0.05 significance level.

As shown in Table 1, the bulk density of the instant porridge, varying with different material ratios and drying temperatures, ranged from 0.63 to 0.76 g/m³. Bulk and solid density are physical properties of food ingredients and grains **[21]**. The bulk density of the instant porridge produced is almost the same as instant millet porridge at 0.57-0.61g/m3 **[22]**. The bulk density of rice and tapioca composite flour ranges from 0.79 to 0.83 g/m³ **[23]**. Bulk density describes the structural changes of a material. The bulk density of instant porridge with rosella flower supplement is 0.72 g/cm3 **[24]**. Higher drying temperatures resulted in higher bulk density. While increasing variations of pumpkin did not show an increase in bulk density. Bulk density is one of the critical parameters in flour-based products **[23]**. The bulk density produced in this study is following instant pumpkin and brown rice porridge **[25]**. Pumpkin has a low starch content, so as the proportion of pumpkin in the ingredients increases, the levels of starch, amylose, and carbohydrates decrease **[26]**. This affects reducing the bulk density of instant porridge. The bulk density in the product will be lower because the material has low starch and protein content **[27]**. The bulk density is closely related to the material's water content. The material's water content loss causes lower bulk density due to evaporation during drying **[28]**. As the drying temperature increases, the rate of water evaporation from the material accelerates, leading to a decrease in the size of the resulting instant porridge and, consequently, a reduction in its density **[29]**.

Yield

The following table displays the results of the instant porridge yields produced from various variations.

Table 2 Yield instant porridge with variations of mocaf, pumpkin, and cowpea flour (%).

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (°C)		
	130	140	150
1:1:1	38.50^{e} ± 1.95	41.40^{f} ± 1.19	41.20^{f} ± 2.87
1:2:1	32.80^{d} ± 2.76	33.00^{d} ± 2.06	31.00^{c} ± 2.17
1:3:1	26.80^{b} ± 1.53	25.20^{a} ± 2.87	26.20^{ab} ± 1.78

Note: Means labeled with the same letter display no statistically significant difference at the 0.05 significance level.

The data in Table 2 illustrate that ingredient and drying temperature ratio variations show interaction. Hence, it has a significant effect on the yield of instant porridge. The treatment involving varying pumpkin ratios shows that the yield decreases as the amount of pumpkin added increases. The yield of instant porridge varies between 25.20% and 38.50%, owing to the high water content of pumpkin, which is 77.62% **[26]**. This is also influenced by adding tempeh to the instant porridge, as tempeh has a reasonably high water content, around 55 g/100 g of ingredients, so the instant porridge mixture tends to have a high amount of water. High water content will evaporate when heated, causing the material to lose its water content, resulting in a small yield.

According to Table 2, a decrease in yield also occurred in the temperature treatment from 140°C to 150°C, decreasing from 33.00–41.40% to 31.00–41.20%. The drying temperature has a significant effect on the yield of instant porridge. As the drying temperature increases, more water evaporates, leading to a reduction in yield. This is supported by a study conducted by **[30]**, which found that lower drying temperatures result in less water evaporation, leading to a higher yield, whereas higher temperatures have the opposite effect. Higher drying temperatures lead to greater water evaporation, which reduces the yield. The starch gelatinisation process also influences the yield during heating. According to **[31]**, the starch content in pumpkin is small, by increasing the proportion of pumpkin in the mixture will result in a decrease in the levels of starch, amylose, and carbohydrates. According to **[32]**, starch is a carbohydrate component that undergoes gelatinisation during drying. When starch is fully gelatinised, it leads to a reduction in carbohydrate content, which in turn results in a smaller weight or yield of instant porridge.

Water absorption

The results of the water absorption of instant porridge with variations are detailed in Table 3.

Table 3 Water absorption of instant porridge with variations of mocaf, pumpkin, and cowpea flour (%).

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (°C)		
	130	140	150
1:1:1	$21.00^{e} \pm 0.00$	$20.42^{d} \pm 0.00$	$19.25^{b} \pm 0.03$
1:2:1	$21.33^{f} \pm 0.00$	$21.00^{e} \pm 0.00$	$20.00^{c} \pm 0.00$
1:3:1	$20.67^{d} \pm 0.00$	$19.33^{b} \pm 0.00$	$18.00^{a} \pm 0.00$

Note: Means labeled with the same letter display no statistically significant difference at the 0.05 significance level.

As evident in Table 3, the water absorption capacity of the instant porridge produced was between 18.00-21.33%. The water absorption capacity observed in this study was higher than that of pumpkin flour without adding mocaf and cowpea flour, which was 11.45 ± 0.58% **[33]**. This is because the instant porridge in this study incorporated mocaf and cowpea flour. Referring to the study of **[34]**, cowpea contains 20.35% protein, including soluble protein, which gives them water absorption properties. Similarly, mocaf has water-absorbing abilities due to its tendency to quickly form a paste during gelatinisation. This is supported by **[35]** that mocaf is easily gelatinised in the noodle-making process. Instant porridge that undergoes gelatinisation will increase the water absorption capacity. The substitution of 15% pumpkin flour in bread can enhance the water binding capacity compared to a 5% substitution **[36]**. Based on **[37]** instant pumpkin porridge substituted with cowpea flour shows a 16.12-22.5% water absorption capacity. Pumpkin contains dietary fibre of 0.5g/100g **[38]**, while the fibre contained in pumpkin cookies is 21.42 g **[8]**.

Oil absorption

The following table presents the results of the analysis conducted on oil absorption of instant pumpkin porridge with various variations.

Table 4 Oil absorption of instant pumpkin porridge with variations of mocaf, pumpkin, and cowpea flour (ml/g)

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (°C)		
	130	140	150
1:1:1	$9.24^{de} \pm 0.00$	$8.90^{cde} \pm 0.00$	$8.13^{ab} \pm 0.00$
1:2:1	$9.39^{e} \pm 0.00$	$8.66^{abcd} \pm 0.57$	$8.01^{a} \pm 0.00$
1:3:1	$8.66^{abcd} \pm 0.47$	$8.515^{abc} \pm 0.46$	$8.80^{bcde} \pm 0.00$

Note: Means labeled with the same letter display no statistically significant difference at the 0.05 significance level.

The findings in Table 4 are summarised that the oil absorption capacity is between 8.01-9.39 ml/g. As indicated by **[39]**, the oil absorption capacity in mung bean flour ranges from 2.05-2.17 g/g. The oil absorption capacity of instant porridge is higher than that of mung bean flour. This is attributed to mocaf and pumpkin in the instant porridge. Both mocaf and pumpkin are fibre-rich, contributing to the increased oil absorption capacity. Oil absorption capacity is an essential functional property related to the sensory properties of the resulting product **[40]**.

Water Absorption Index

The experimental results for the water absorption index of instant pumpkin porridge under various variations are summarised in the following table 5.

Table 5 shows that the Water Absorption Index (WAI) of instant porridge made of mocaf, pumpkin, and cowpea flour at various drying temperature variations is 3.63g/g-4.21g/g. Table 5 also reveals that a higher proportion of pumpkins increases the water absorption index. The difference in the average WAI value is influenced by the type of composite flour **[41]**. The higher the temperature, the higher the water absorption index. WAI is also highly influenced by the carbohydrate content of the ingredients **[42]**. Instant pumpkin porridge substituted with mung beans has a WAI of 5.32-6.62 g/g **[37]**. Fiber content will increase WAI significantly due to its ability to form gels and retain water **[27]**. Protein content can also increase WAI in mung bean protein isolate flour **[30]**. Based on a study by **[43]**, mung beans have a 25-28% protein content.

Table 5 Water absorption index of instant pumpkin porridge with mocaf, pumpkin, and cowpea flour variations (g/g).

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (°C)		
	130	140	150
1:1:1	$3.63^{a} \pm 0.12$	$3.5^{bc} \pm 0.00$	$3.74^{ab} \pm 0.04$
1:2:1	$3.82^{b} \pm 0.10$	$3.97^{bc} \pm 0.06$	$4.24^{f} \pm 0.00$
1:3:1	$4.07^{cd} \pm 0.00$	$4.21^{f} \pm 0.00$	$4.15^{ef} \pm 0.00$

Note: Means labeled with the same letter display no statistically significant difference at the 0.05 significance level.

Colour

The photo showing the colour of the instant porridge with different mixture variations is displayed in Figure 1. Figure 1 displayed that the higher the pumpkin content, the more yellow or orange the instant porridge appears. According to **[5]** pumpkin has β-carotene of 317–341 µg/g. The β-carotene compounds in pumpkin contribute to its orange colour **[44]**. In addition, the detailed breakdown of colour results from instant porridge with various variations is shown in Table 6.

Lightness (L)

As reported in Table 6, The Colour L shows that the more significant proportion of pumpkin and the higher temperature affect the decrease in lightness. This is because a higher proportion of pumpkin boosts the levels of beta-carotene, which imparts an orange colour. Beta carotene is sensitive to damage from oxygen and heat **[45]**. Beta carotene damage can affect the brightness level of instant porridge. This is because a higher proportion of pumpkin results in a less vibrant colour, and increased baking temperatures also decrease the brightness. Pumpkin flour contains sugar and amino acid compounds, and will experience Maillard reactions and carotenoid oxidation during the extrusion process, which produces brown substances **[46]**.

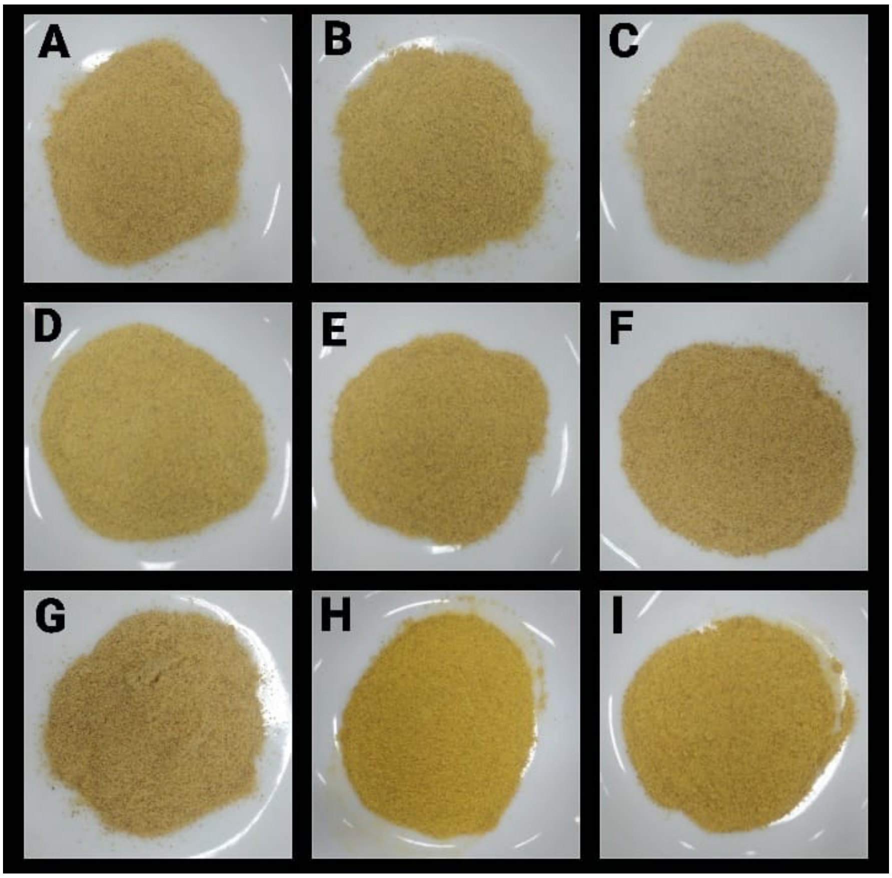

Figure 1. Photo of the instant porridge colour results.
Note: A: 1:1:1, 130°C B: 1:2:1, 130°C, C: 1:3:1, 130°C, D: 1:1:1, 140°C E: 1:2:1, 140°C F: 1:3:1, 140°C, G: 1:1:1, 150°C, H: 1:2:1,150°C, I: 1:3:1, 150°C.

Table 6 The colour of instant porridge with variations of mocaf, pumpkin, and cowpea flour.

Variation of mocaf: pumpkin: cowpea flour	Drying Temperature (°C)	L	a	b
1:1:1	130	67.73^{f} ± 0.00	6.13^{d} ± 0.00	20.43^{c} ± 0.00
1:2:1	130	63.73^{c} ± 0.00	4.78^{a} ± 0.00	43.30^{f} ± 0.00
1:3:1	130	65.97^{e} ± 0.00	7.58^{g} ± 0.00	51.17^{g} ± 0.00
1:1:1	140	65.50^{d} ± 0.00	4.99^{b} ± 0.18	21.03^{d} ± 0.14
1:2:1	140	63.77^{c} ± 0.00	5.99^{d} ± 0.07	19.84^{b} ± 0.00
1:3:1	140	60.77^{a} ± 0.00	5.78^{c} ± 0.00	23.07^{e} ± 0.39
1:1:1	150	63.88^{c} ± 0.40	5.81^{c} ± 0.11	19.08^{a} ± 0.00
1:2:1	150	60.58^{a} ± 0.00	7.32^{f} ± 0.00	19.00^{a} ± 0.00
1:3:1	150	61.17^{b} ± 0.00	7.11^{e} ± 0.00	23.43^{e} ± 0.36

Note: Means labeled with the same letter within the same column display no statistically significant difference at the 0.05 significance level.

Redness (a)

The variation in the redness value of instant porridge with different drying temperatures shows that as the temperature increases, the redness also intensifies. The redness value of instant porridge ranges from 4.78 to 7.58, which is lower than that of dried pumpkin slices, where the redness value falls between 9.98 and 11.07 **[47]**. The instant porridge is made with pumpkin, mocaf, and cowpea flour, rather than pure pumpkin. The redness in dried fruits occurs due to a non-enzymatic browning reaction **[48]**.

Yellowness (b)

The yellowness value of instant porridge ranges from 19.00-51.17. The average yellowness value is higher than instant porridge enriched with mung bean flour, between 25.91 and 28.38 **[37]**. This is due to using pumpkin as the raw material, which will contribute to the yellow colour. The greater the variety of pumpkins, the more intense the yellow colour will become. The results of this study are relevant to the findings of **[49]** that the yellowness value will increase with the increasing substitution of yellow pumpkin flour in biscuits. The yellow colour increases in instant porridge because yellow pumpkin has beta-carotene pigment. The beta carotene content in yellow pumpkin is 63.4 mg/100 g of material **[31]**.

Preference-level instant porridge

Organoleptic tests were conducted at the Organoleptic Laboratory of the Faculty of Agroindustry, Universitas Mercu Buana Yogyakarta, Indonesia. A total of 36 semi-trained panellists were involved in this organoleptic test. The organoleptic properties of each sample were assessed on a scale of 1-5 (1 = very dislike, 2 = dislike, 3 = neutral, 4 = like, and 5 = very like). Panellists assessed colour, aroma, taste, viscosity, and overall sensory. The panel consisted of 40 participants, including 33 females and 7 males. Ethical clearance for sensory testing has been granted by the ethics commission of Universitas Alma Ata Yogyakarta with an approval number: KE/AA/VI/10111962/Ec/2024. The preference level of instant porridge is presented further in Table 7.

Table 7. The preference of instant pumpkin porridge with variations of mocaf, pumpkin, and cowpea flour.

Temp (°C)	Variation of mocaf: pumpkin: cowpea flour	Parameter				
		Colour	Smell	Flavor	Thickness	Overall
130	1:1:1	2.35^{a} ± 0.00	3.05^{a} ± 0.06	2.70^{a} ± 0.01	2.95^{bc} ± 0.17	2.80^{a} ± 0.04
130	1:2:1	3.25^{b} ± 0.10	2.90^{a} ± 0.14	2.95^{a} ± 0.04	3.55^{bc} ± 0.03	3.10^{a} ± 0.13
130	1:3:1	4.15^{c} ± 0.07	4.10^{b} ± 0.00	4.85^{b} ± 0.12	4.45^{d} ± 0.00	4.30^{b} ± 0.11
140	1:1:1	3.05^{ab} ± 0.00	3.00^{a} ± 0.01	2.40^{a} ± 0.03	3.65^{c} ± 0.12	2.85^{a} ± 0.01
140	1:2:1	3.00^{ab} ± 0.01	3.05^{a} ± 0.20	2.65^{a} ± 0.00	3.50^{bc} ± 0.01	2.95^{a} ± 0.03
140	1:3:1	3.10^{ab} ± 0.04	3.10^{a} ± 0.01	2.70^{a} ± 0.10	2.85^{ab} ± 0.04	3.00^{a} ± 0.01
150	1:1:1	2.70^{ab} ± 0.12	2.60^{a} ± 0.10	2.60^{a} ± 0.05	3.10^{bc} ± 0.10	2.75^{a} ± 0.10
150	1:2:1	2.80^{ab} ± 0.09	2.80^{a} ± 0.04	2.80^{a} ± 0.01	3.30^{bc} ± 0.02	3.15^{a} ± 0.09
150	1:3:1	3.15^{b} ± 0.04	3.05^{a} ± 0.08	2.80^{a} ± 0.00	2.20^{a} ± 0.13	2.80^{a} ± 0.02

Note: Means labeled with the same letter within the same column display no statistically significant difference at the 0.05 significance level.

As outlined in Table 7, the preference test results show that each treatment of material variations and drying temperatures showed different values in all test components, including color, taste, aroma, texture, aftertaste, and overall evaluation. On a scale of 1-5, instant porridge at a drying temperature of 130ºC and variations of motif: pumpkin: cowpea flour had the highest assessment from the panelists, with an average score of 4.34. Among the samples, the instant porridge received the highest preference from the panelists.

Table 7 indicates that the instant porridge most favoured by the panellists is made with a 1:3:1 ratio of mocaf, pumpkin, and cowpea flour and dried at a temperature of 130°C. Statistical analysis shows that adding mocaf-pumpkin and cowpea flour affects the instant porridge's colour, taste, texture and taste attributes ($p<0.05$). The colour of instant porridge is influenced by the amount of pumpkin, which is more significant than that of other treatments. The colour of instant porridge is primarily affected by the amount of pumpkin, which is higher than in different treatments. A drying temperature of 130°C is the lowest compared to the other treatments, and lower drying temperatures help minimise the damage to beta-carotene. Pumpkin has an all-trans beta-carotene content of 19.45 ± µg/g **[50]**. In the sensory test of mocaf-pumpkin cookies with a ratio of 77.5:22.5% **[51]**. Based on the research conducted by **[52]**, panellists prefer instant porridge made from mocaf with more tempeh flour.

Chemical composition of instant porridge

The chemical composition of instant porridge produced from variations of mocaf, pumpkin, and cowpea flour with variations in drying temperature is presented in Table 8.

Table 8 Chemical composition of instant porridge with variations of mocaf, pumpkin, and cowpea flour and temperature.

Temp (°C)	Variation of mocaf: pumpkin: cowpea flour	Parameter							
		Water (%)	Ash (%)	Protein (%)	Fat (%)	Carbohydrate by different (%)	Phenol (µg/g)	Beta-carotene (µg/g)	Antioxidant activity (%RSA)
130	1:1:1	$3.65^{ab}\pm 0.13$	$3.19^{a}\pm 0.27$	$19.83^{d}\pm 2.13$	$4.89^{a}\pm 1.17$	$68.44^{a}\pm 3.97$	$534.09^{b}\pm 9.27$	$267.89^{f}\pm 5.97$	$16.82^{e}\pm 2.05$
130	1:2:1	$3.71^{b}\pm 0.04$	$3.25^{a}\pm 0.12$	$18.75^{cd}\pm 1.97$	$5.03^{b}\pm 0.95$	$69.26^{a}\pm 3.45$	$676.16^{e}\pm 5.84$	$342.56^{g}\pm 2.62$	$19.05^{f}\pm 1.78$
130	1:3:1	$3.78^{b}\pm 0.08$	$3.33^{b}\pm 0.12$	$18.53^{c}\pm 1.08$	$5.19^{c}\pm 0.67$	$69.17^{a}\pm 3.01$	$774.57^{g}\pm 7.71$	$451.67^{h}\pm 9.87$	$20.29^{g}\pm 1.17$
140	1:1:1	$3.54^{a}\pm 0.01$	$3.19^{a}\pm 0.31$	$17.73^{b}\pm 1.08$	$5.05^{b}\pm 0.81$	$70.49^{b}\pm 2.37$	$501.97^{a}\pm 6.63$	$231.75^{e}\pm 6.52$	$12.02^{c}\pm 1.09$
140	1:2:1	$3.60^{a}\pm 0.14$	$3.27^{ab}\pm 0.25$	$17.08^{b}\pm 1.74$	$5.16^{c}\pm 0.56$	$70.89^{b}\pm 2.04$	$659.47^{d}\pm 5.50$	$314.20^{d}\pm 4.71$	$12.95^{d}\pm 1.16$
140	1:3:1	$3.68^{a}\pm 0.05$	$3.36^{b}\pm 0.17$	$16.89^{b}\pm 2.10$	$5.25^{c}\pm 1.02$	$70.82^{b}\pm 1.96$	$765.78^{f}\pm 4.79$	$361.13^{c}\pm 4.90$	$13.70^{d}\pm 0.95$
150	1:1:1	$3.45^{a}\pm 0.12$	$3.23^{a}\pm 0.21$	$15.28^{a}\pm 1.22$	$5.08^{b}\pm 0.42$	$72.96^{d}\pm 1.63$	$543.95^{c}\pm 7.04$	$187.54^{b}\pm 5.62$	$9.38^{a}\pm 1.78$
150	1:2:1	$3.50^{a}\pm 0.05$	$3.20^{a}\pm 0.28$	$15.95^{a}\pm 2.08$	$4.97^{a}\pm 0.77$	$72.38^{c}\pm 1.07$	$669.64^{de}\pm 8.31$	$150.76^{a}\pm 4.93$	$10.53^{a}\pm 1.36$
150	1:3:1	$3.57^{a}\pm 0.16$	$3.39^{b}\pm 0.11$	$15.02^{a}\pm 2.32$	$5.22^{c}\pm 0.54$	$72.80^{cd}\pm 2.09$	$763.93^{f}\pm 4.82$	$193.40^{b}\pm 3.47$	$11.01^{b}\pm 1.21$

Note: Means labeled with the same letter within the same column display no statistically significant difference at the 0.05 significance level.

The water content of instant porridge can be seen in Table 8, which shows that the drying temperature treatment and variations of mocaf, pumpkin, and cowpea flour did not significantly affect the water content. The water content of instant porridge is between 3.45-3.78%. This occurs because the drying temperature used is 130°C-150°C. The water content of the instant porridge produced meets the requirements of the Indonesian National Standard of a maximum of 4%. The water content of instant porridge is lower than pumpkin porridge dried at a temperature of 50°C-70°C **[53]**. Pumpkin powder containing below 5% will have a long shelf life **[54]**. Egg rolls with a water content of 4.01% packaged in polypropylene plastic have a shelf life of 1.8 months **[55]**.

The ash content of instant porridge showed no significant difference between treatments. The ash content of the instant porridge produced ranged from 3.19-3.36%. This is likely because the ash content of the three key ingredients is almost the same. The ash content of the instant porridge produced was higher than that of instant porridge enriched with protein, which was 1.7-2.5% **[56]**.

The protein content of instant porridge ranges from 15.28-19.83%. The protein found in instant porridge is primarily sourced from cowpea flour. The protein concentration in cowpea flour spans 24.30-26.33%**[12]**. This is attributed to the fact that mocaf and pumpkin have low protein levels. Adding cowpea flour increases the protein content of flatbreads **[57]**. The protein content is comparable to the 16.50-20.15% range in instant porridge made with nuts and rosella flowers **[24]**.

The fat content of the instant porridge produced ranges from 4.89-5.22%. The fat content in instant porridge primarily comes from cowpea flour. Cowpea has a fat content of between 5-7% **[13]**. The fat content surpasses instant porridge mixed with pumpkin and brown rice at 3.70% **[25]**.

Carbohydrates produced by different instant porridge range from 68.44-72.96%. The Carbohydrate by different content is sourced mainly from mocaf, which is rich in starch. Mocaf has a starch content of 73.29% **[58]**. Meanwhile, pumpkin and cowpea flour are key sources of fiber. The addition of pumpkin to the sub increases dietary fiber **[3]**. The fiber content in cowpea ranges from 9.36-12.86% **[12]**.

The phenol content of instant porridge ranged from 501.97-774.57 µg/g. The phenol content mainly originates from pumpkin, which contains quinic acid and amentoflavone as its major phenol components **[59]**. The total phenol content is higher than powdered drinks enriched with pumpkin, which is 360 µg/g **[60]**. A large amount of pumpkin added to the instant porridge-making process affects the result.

The beta-carotene content of instant porridge ranges from 150.76-451.67µg/g. Table 8 demonstrates that the drying temperature treatment influences the beta-carotene content. An increase in drying temperature results in a decrease in beta-carotene content. The beta-carotene content rises with more variations of pumpkin, given that pumpkin is naturally rich in beta-carotene. The beta carotene content of instant porridge is lower than that of cookies mixed with mocaf and pumpkin 1.089 µg/g. This occurs because the amount of pumpkin used in making the instant porridge is lower than that used in the cookies. Beta carotene is susceptible to damage due to the influence of process factors, especially high temperatures.

The antioxidant activity of instant porridge ranges from 9.38-20.29% RSA. Adding more variations of pumpkin increases the antioxidant activity in instant porridge. Pumpkin is a source of antioxidants that have the potential as hypoglycemic **[61]**. Noodles substituted with pumpkin and sweet potato exhibit higher antioxidant activity than those without pumpkin **[62]**. The antioxidant activity is higher than that of cookies mixed with mocaf and pumpkin, with a variation of 77.5% : 22.5%, which was 14.03% **[51]**. Pumpkin is a potential source of antioxidants and has hypoglycemic properties.

CONCLUSION

This study formulated a total of 9 instant porridge samples and analyzed the physical properties, chemical composition, and preference level. The level of preference for instant porridge was tested by panellists with parameters of colour, smell, flavour, thickness, and overall preference. As a result, the most preferred by panelists is the treatment of mocaf, pumpkin, and cowpea flour variations 1:3:1 with a drying temperature of 130°C. The physical properties of the instant porridge include: bulk density, water absorption capacity, oil absorption capacity, and water absorption index, respectively: 0.65 g/m^3, 20.67%, 8.66 ml/g, and 4.07 g/g. Other physical properties are lightness, redness, and yellowness values of 65.97, 7.58, and 51.17, respectively. The chemical composition analyzed in this study revealed water content of 3.78%, ash 3.33%, protein 18.53%, fat 5.19%, carbohydrate by different 69.17%, phenol 774.57 µg/g, beta carotene 451.67µg/g, and antioxidant activity 20.29% RSA. In summary, instant porridge with a mixture variation of 1:3:1 by a drying temperature of 130°C in this study shows a potential to serve as a functional food. Further studies are needed to strengthen and develop the findings of this study, helping to better understand the health benefits of pumpkin porridge mixtures.

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This study obtained ethical clearance from the Ethical Commission of Universitas Alma Ata, Indonesia, with Ref. Number: KE/AA/VI/10111962/Ec/2024.

AI Statement:

This research is conducted and based on in-house laboratory experiments and does not involve the use of AI tools at any stage.

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