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Developing a nutritious soup product using purple sweet potatoes supplemented with composite of vegetables and freezed-dried chicken

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Abstract

This research aimed to develop a nutritious instant purple sweet potato soup (PSP) combination with a variety of vegetables and freeze-dried chicken. The nutritional characteristics of the product were evaluated. The current study employs principal component analysis (PCA), consumer preference mapping, and check-all-that-apply (CATA) data processing to describe sensory instant mixed soup attributes. The results showed that the soup was made from the formula F2 (PSP flour 47.5%, orange-fleshed sweet potato flour 12.5%, potatoes 6%, banana 7%, mushroom 8%, petit poise 3%, pumpkin 5%, protein powder 5% and cream powder 6%) gave good quality, high sensory value and attractive colors product. The PCA identified important soup attributes such as sweetness, milk flavor, vegetable odor, and color. Adding 15% freeze-dried chicken improved the quality of mixed soup products with energy distribution from macronutrients: proteins 24%, carbohydrates 65%, and lipids 10%. The anthocyanin and β-carotene content analyzed from the product was 13.1 mg/100 g and 370.2 μg/100 g. Score analysis according to the CATA model with two main components accounting for 95.57% of the variance in sensory attribute data, showing liking attributes of mixed soup sample that the panelists preferred in color, flavor, chicken meat distribution, and sweetness. The essential nutritional characteristics of mixed soup have been carefully analyzed.

Keywords: mixed soup; purple sweet potato; nutritional characteristics; ingredients; sensory evaluation.

Practical Application: Soups are a great nutritious meal option. Plant-based diets not only reduce the risk of developing an illness (such as COVID-19) but also reduce symptom severity for people already infected with the virus and help recover from illness. Additionally, eating plenty of protein-rich foods is essential for maintaining muscle mass when you reduce physical activity. The present study aims to develop a mixed soup from purple sweet potato supplemented with some vegetables with good nutritional characteristics and freeze-dried chicken. The product is acceptable from a technological and sensory point of view, which can help the food industry to provide nutritious food to consumers of different ages, especially those who are sick or in recovery period.

1 Introduction

Typically, a healthy diet includes nutrient-dense meals from all of the major food groups, such as animal/vegetable proteins, whole grains, healthy fats, and colorful veggies. These foods can also help support the body's immune system to fight disease and enhance speed recovery. For example, COVID-19 causes inflammation in the body like any virus (Wong, 2021); plant-based diets not only reduce the risk of developing COVID-19 but also reduce symptom severity for people already infected with the virus (Kim et al., 2021; Uğur & Buruklar, 2021) and also help with recovery from illness (Tuso et al., 2013). In addition, eating plenty of protein-rich foods is essential to maintain muscle mass when you reduce physical activity. Besides, by evaluating the diet's prospective renal acid load, the diet effect on systemic acid load can be measured (PRAL). It refers to the amount of acid produced when food is digested. The higher the PRAL, the more acid is produced (Scialla & Anderson, 2013). It also means that the kidneys have to work harder. Therefore, people with poor kidney function should consider their PRAL food intake. Generally, fruits and vegetables promote systemic alkalinity (Caciano et al., 2015). When consumed, an alkaline diet can improve overall nutrient density and reduce the chronic diseases risk (Thompson & Manore, 2017).

Animal protein is also a good choice, although plant-based proteins have better anti-inflammatory properties than animal proteins. Besides, fluid balance is essential when the body is battling a respiratory illness, and dehydration can thicken respiratory secretions and make them difficult to clear from the lungs. Semi-solid products from diverse sources of high-value raw materials can meet the body's needs in this epidemic condition. Moreover, today consumers are demanding more convenience and health-promoting products. Therefore, convenience ready-made food products, including soup, are considered instant products in the main food category (Jayasinghe et al., 2016).

The issue of concern is the selection of high-quality materials for product processing, patient support, or during recovery. Several works on combining sources of vegetables and fruits with high nutritional value in processing instant nutritional soup powders have also been carried out (Keomixay et al., 2019; Saphaothong et al., 2019; Tai et al., 2019; Thuy & Tai, 2020;

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Thuy et al., 2020a, b). The formulation and nutritional analysis of a nutritious vegetable soup containing soy flour, mushrooms, and moringa leaves have been investigated (Farzana et al., 2017). Islam et al. (2018) investigated the formulation and quality assessment of protein-rich instant mixed soup products. Moringa-garden cress instant soup mix was developed as a superior nutrient and sufficient to meet daily nutritional requirements as dietary supplements Kokani et al. (2019). The efficacy of supplemental instant functional soup mix for the elderly was reported by Mohamed et al. (2020). All studies have paved the way for incorporating a variety of local botanical sources available in their countries to support good health. However, in Vietnam, studies on the combined use of high-biological value animal/vegetable sources in preparing soup products (semi-solid) are still limited. This study used purple sweet potatoes (PSP) and other high-quality vegetables, including orange-flesh sweet potatoes (OFSP), potatoes, bananas, pumpkin, mushrooms, and beans. These foods are rich providers of carbs, protein, vitamins, minerals, fiber, and phytochemicals (Borges-Martínez et al., 2022; Kim et al., 2012; Zhang et al., 2022). The sweet potatoes deep purple color is due to the accumulation of anthocyanins which are capable of delivering a variety of biological functions, including free radical scavenging and anti-cancer properties (Phomkaivon et al., 2018). Some of the combined vegetables have many specific bioactive compounds, such as carotenoids and polyphenols have many biological properties, including antioxidant activity, anti-aging, anti-inflammatory, anti-viral, anti-bacterial, and anti-cancer (Li et al., 2016; Xu et al., 2017). Chicken combined with a variety of vegetables will form a convenient, nutritious soup with high nutritional and sensory value, ensuring the completeness and balance of necessary dietary ingredients that will benefit many peoples, including patients, during treatment and recovery, especially during a prolonged COVID epidemic.

2 Materials and methods

2.1 Raw materials and ingredients

PSP and OFSP were harvested from Vinh Long province. In addition, p*etits pois* (*Pisum sativum*), potatoes, mushrooms, "Xiêm" banana, pumpkin, spices...were obtained from the local market. The plant-based organic protein (Leanfit, Canada) and fat-filled milk powder (28% of fat-Natur'lait, France) were used in all formulas.

2.2 Chemicals

All of the chemicals utilized were of analytical reagent quality.

2.3 Preparation of raw materials

PSP and OFSP flours were prepared according to the procedures by Thuy et al. (2020a, 2022), respectively. The flour should pass through a 100 μm sieve and package inside a plastic container for further use. Bananas, potatoes, and pumpkin were washed, peeled, washed again, sliced, and blanched with steam water at 100 °C for 3 minutes to facilitate the grinding process. The freeze-dried chicken breast was prepared following the previous study of Thuy et al. (2020b).

2.4 Preparation and formulation of soup made with purple sweet potatoes and a variety of vegetables

Table 1 depicts the production and composition of the blended soups. Four soup combinations were created by combining the ingredients first (with three replicates for each formula), namely S1, S2, S3, and S4. Next, water was added at twice the rate of the total materials. Then the mixture was ground with a Food Grinder (APWONE 2000 gram Electric Grain Mills Grinder, USA) with particle size between 50 to 300 mesh. Finally, the freeze-dried chicken was preliminary added at a fixed content of 9% (calculated based on the total ingredients shown in the Table) for all recipes.

The soup was cooked at boiling temperature for 3 minutes. It is then poured into a glass bottle with a net weight of 200 g. The *sterilization* process was accomplished by heating the product rapidly *t*o 125 °C with 5 minutes of holding time (based on calculated F value), then rapidly cooling the product after taken out. The quality of products was analyzed in terms of nutrients and sensory. In addition, the total energy and energy providedby macronutrients were determined.

2.5 Quality analysis

Standard procedures were utilized to evaluate the protein, fat and crude fiber content of raw materials and products (Association of Official Analytical Chemists, 2005). The total carbohydrate content was determined according to the method of McCseady (1970) and DuBois et al. (1956). The β-carotene content was determined according to Fikselová et al. (2008). Using the pH

Table 1. Formulation of the healthy soup from purple sweet potatoes and other vegetables.

Ingredients	S1 (%)	S2 (%)	S3 (%)	S4 (%)
PSP flour	50	47.5	45	42.5
OFSP flour	10	12.5	15	17.5
Potatoes	8	6	4	2
Banana	5	7	9	11
Mushroom	8	8	8	8
Petit poise	3	3	3	3
Pumpkin	5	5	5	5
Plant-based organic protein	5	5	5	5
Fat filled milk powder	6	6	6	6
Total	100	100	100	100

differential method, the anthocyanin concentration (expressed as cyanidin-3-glucoside equivalents) was measured (Maran et al., 2015). Calcium, sodium, and potassium concentrations were determined using Flame photometry (FP6410 Flame Photometer) (Arunkumar et al., 2015). The iron concentration was determined using a UV-Vis Spectrophotometer in accordance with Hailu et al's approach (Hailu et al., 2019). The vitamin C content was measured according to the method of Zvaigzne et al. (2009). The color (L* values) of the sample were recorded using a Colorimeter (Japan).

2.6 Total calories (kcal)

The total number of calories was calculated by multiplying the percentages of protein, fat, and carbohydrates by their corresponding physiological fuel value.

2.7 Estimation of PRAL

The Potential Renal Acid Load (PRAL) of foods was determined to evaluate a food's acidifying or alkalinizing potential, as shown in the Equation 1.

$$PRAL = P\ x\ 0.0366 + Pro\ x\ 0.4888 - \left(K\ x\ 0.0205 + Ca\ x\ 0.0125 + Mg\ x\ 0.0263\right) \quad (1)$$

Where the units for PRAL are mEq/day and P is in mg/day, Pro is in g/day, K is in mg/day, Ca is in mg/day, and Mg is in mg/day (Remer & Manz, 1995).

2.8 Sensory evaluation

Twenty panelists did a Check-All-That-Apply (CATA) and Quantitative Descriptive Analysis (QDA) sensory evaluation of soup samples. Briefly, a questionnaire was used to choose the panelists in order to assess their interest in serving on a sensory panel, availability, and health status. In accordance with International Organization for Standardization (2012) norms, 20 panelists were chosen to take part in a sensory descriptive panel (Los et al., 2021; Cais-Sokolińska et al., 2021). The sample was described by five descriptive qualities: milk flavor, consistency, vegetable smell, sweet taste, and color. Three random digits were used to identify each sample across all sessions. The attributes were established for the "CATA" analysis during the initial descriptive assessment processes, which grouped terms used in similar projects and adapted for the CATA analysis. The acceptance test (hedonic scale) and the CATA test were both included on the evaluation form that was given to each assessor.

2.9 Data analysis

Data analyses were conducted using STATGRAPHICS Centurion XV (USA). The values were presented as the mean ± standard deviation. In addition, principle component analysis (PCA) was applied using XLSTAT (Addinsoft, 2017) for sensory data analysis (Sola-Larrañaga & Navarro-Blasco, 2009). PCA is also combined with the CATA data processing method to describe the product's sensory attributes.

3 Results and discussions

3.1 Estimation of some chemical components of ingredients used

Choosing ingredients to combine in healthy soup is to prioritize the elderly and patients during the treatment and recovery period, especially in the country's prolonged state of COVID-19 disease. The approximate analytical results of the ingredients used in the recipes are presented in Table 2.

It can be seen that the ingredients provide the desired variety of nutrients. In addition, a product made up of these combined ingredients creates a well-balanced diet, which means it contains nearly all foods from all the major food groups in the right amounts. These food groups are whole grains, vegetables, proteins, dairy, and fats. In general, they are fully included in the group of ingredients selected for the design of the formulations.

Vegetables are foods that contain phytonutrients, which help prevent diseases and maintain the normal functioning of the body. Among them, carotenoids, flavonoids, and resveratrol are the components that impact health the most. In addition, the majority of plant-based foods include many pigments, often each matching to a phytonutrient (Minich, 2019). Consequently, the consumption of plant-based diets is substantially associated with a reduction in chronic disease (Liu, 2013). Moreover, a diet

Table 2. Proximate analysis of ingredients.

Ingredients	Mois. (%)	Pro. (%)	Carb. (%)	Fat (%)	Ash (%)	Fiber (%)	Antho. (mg/g)	β-caro. (μg/g)
PSP flour	9.2 ± 0.5	3.1 ± 0.1	74.7 ± 0.5	0.6 ± 0.0	1.9 ± 0.1	5.9 ± 0.1	0.9 ± 0.0	-
OFSPflour	12.2 ± 0.2	2.4 ± 0.2	75.6 ± 0.5	1.8 ± 0.1	1.8 ± 0.0	5.7 ± 0.2	-	80.4 ± 0.2
Potato	76.6 ± 0.7	2.1 ± 0.1	18.1 ± 0.1	-	1.1 ± 0.0	1.4 ± 0.1	-	-
Banana	72.9 ± 0.5	1.1 ± 0.0	20.8 ± 0.2	0.3 ± 0.0	0.8 ± 0.0	2.6 ± 0.1	-	2.9 ± 0.1
Mushroom	87.9 ± 0.7	3.2 ± 0.1	5.8 ± 0.1	-	-	2.2 ± 0.1	-	-
Peas	76.2 ± 0.3	4.3 ± 0.2	12.4 ± 0.1	0.2 ± 0.0	0.7 ± 0.0	4.7 ± 0.1	-	
Pumpkin	90.6 ± 0.6	1.1 ± 0.1	6.5 ± 0.1	0.2 ± 0.0	-	0.5 ± 0.0	-	21.9 ± 0.5
***Plant pro.**	3.85	60.76	20.60	-	-	14.11	-	-
***Milk powder**	5.25	24	34	28	-	0	-	-
Freeze-dried chicken	7.0	80.9	-	8.7	-	-	-	-

Mois.: Moisture content, Pro.: protein, Carb.: Carbohydrate, Antho.: anthocyanin, β-caro.: β-carotene; Plant- pro.: Plant-based organic protein. Values were expressed as the Mean ± standard deviation; *Published Data on commercialized product; -: No analysis.

rich in anti-inflammatory plant substances, such as polyphenols and other phytochemicals, may mitigate the toxicity of pollutants (Hoffman et al., 2017). Consequently, following a plant-based diet can minimize our sensitivity to illness risks under working settings exposed to hazardous environmental pollutants.

3.2 Effect of mixing ratio of ingredients (from four recipes) on the nutritional and sensory value of products

The composition of nutrients inmixed soupsis prepared according to 04 recipes

The mixed soup's composition of macronutrients, ash, and fiber was prepared according to 04 recipes (Table 3). It was revealed that the protein and fat composition of all samples did not differ significantly, with the protein ranging from 5.05 to 5.09% and lipid from 1.02 to 1.06%, respectively. It is because the main protein content in the product comes from freeze-dried chicken (9% of the total weight of each recipe) and Plant-based organic protein (5%) that has been fixed in the formula. Besides, the lipid content is mainly from freeze-dried chicken and Fat filled milk powder (6%), so they gave similar results in the procedures. However, slight differences in carbohydrate content were found in the formulas, in which formula S4 gave the highest value (16.54%) and the lowest was found in formula S1 (16.44%). It is because OFSPs have a higher carbohydrate content, which results in increased carbohydrate intake when designing them with more content in the recipe.

The main difference between the formulas was the anthocyanin and β-carotene content. Formula S1 and S2 gave high anthocyanin content (13.8 ± 0.1 and 13.1 ± 0.2 mg%), while formula S3 and S4 contained higher content of β-carotene (425.6 ± 12.5 and 490.7 ± 10.2 µg%) than the other 2 formulas (295.6 ± 6.4 and 360.6 ± 8.5 µg%). It is understandable because the anthocyanin content in the soup entirely depends on the amount of PSP used. In contrast, the β-carotene content depends on the 3 primary sources in the recipe such as OFSP, banana, and pumpkin. Therefore, the concentrations used in the designed formulas demonstrate these results.

Previous research has linked anthocyanins with many health benefits, including increased longevity, heart health, cancer prevention, and dementia. Anthocyanins may also improve vision and have neuroprotective effects. In addition, ingesting anthocyanin-rich foods has positive health impacts on a variety of conditions connected to cancer, aging, obesity, neurodegenerative diseases, inflammation, diabetes, and bacterial infections (Sancho & Pastore, 2012).

β-carotene increase the number and activity of immune cells, an antioxidant that improves immune function (Cui et al., 2012). β-carotene also enhances cancer-fighting immune function in healthy people. In addition to being an antioxidant and precursor to vitamin A, β-carotene may be more important in our diets than vitamin A since people with low tissue levels of β-carotene are more susceptible to several types of cancer (Paolini et al., 2003).

High-fiber carbohydrates are essential because people must have a certain content of fiber each day. A high-fiber diet may reduce the risk of cardiovascular disease, diabetes, diverticulitis, constipation, and colon cancer, among others. Fiber is also essential for digestive health and cholesterol reduction (Thompson & Manore, 2017).

The color of product from 4 recipes

After mixing the ingredients at different ratios, the product's color is shown in Figure 1. The highest and lowest L* values are shown in samples S4 (40.78) and S1 (29.56), respectively, with the lowest and highest purple sweet potato content designed in the recipe. The results are similar to Taneya's (Taneya et al., 2014) report when increasing the percentage of sweet potatoes in the product can reduce the L* value. The L* value gives the best color in sample F2 (34.11).

Sensory evaluation

The sensory quality of the product is analyzed by a professional sensory panel consisting of 15 members trained to evaluate according

Table 3. Proximate analysis of mixed soup.

Soup Code	Protein (%)	Carb. (%)	Lipid (%)	Ash (%)	Fiber (%)	Antho. (mg%)	β-carotene (µg%)
S1	5.09 ± 0.05*	16.44 ± 0.07	1.02**	0.54**	1.20 ± 0.01	13.8 ± 0.1	295.6 ± 6.4
S2	5.08 ± 0.03	16.47 ± 0.05	1.04	0.53	1.23 ± 0.02	13.1 ± 0.2	360.6 ± 8.5
S3	5.07 ± 0.05	16.50 ± 0.05	1.05	0.53	1.25 ± 0.01	12.4 ± 0.2	425.6 ± 12.5
S4	5.05 ± 0.02	16.54 ± 0.03	1.06	0.53	1.27 ± 0.03	11.7 ± 0.2	490.7 ± 10.2

*Values were expressed as the Mean ± standard deviation; **The STD values are very small so they are not shown.

Figure 1. The color of purple sweet potato soup supplemented with chicken and other vegetables. From left to right: formulas S1, S2, S3 and S4.

to the QDA method as previously mentioned in section 2.8. Principal component analysis (PCA) uses organoleptic analysis of product samples mixed with different proportions of ingredients. Besides, the frequency of attributes indicating the organoleptic characteristics of significant interest to PSP soup supplement with other vegetables and chicken include purple color, milk flavor, consistency, sweet taste, and vegetable smell. These are the essential attributes that determine this type of product choice. The relationship between the sensory characteristics and the two principle components (PC) selected to represent the collected sensory data (Figure 2). These attributes are divided into three distinct regions based on the distribution of sensory characteristics. Region 1 includes features such as the milk flavor, while Zone 2 consists of 3 attribute: consistency, vegetable smell and sweetness. Area 3 includes the color property. The consistency attribute is far from the PC_1 axis (first PC), so this property has little effect on PC_1. On the other hand, the color property is next to the PC_2 axis (second PC), so the PC_2 depends heavily on the color property. In addition, attributes such as color, vegetable smell, and sweetness are located near the F_1 axis. Thus, the PC_1 is most influenced by the attributes of color, vegetable smell, and sweetness.The distribution of soup recipes on the graph (Figure 3) showed that the design formulas greatly influence the soups' sensory properties. Formula groups S1 and S4, located far from the PC_1axis, have low sensory scores, too-dark or too-light color, soft sweetness, and difficult-to-recognize vegetable smell. Sample groups S2 and S3 close to the PC1 axis were evaluated as having moderate purple color and characteristics of purple sweet potato, vegetable smell, milk flavor, consistency, and sweetness, which most sensory assessors accepted. The preference mapping also showed similar results (Figure 4) when different formulas were evaluated according to preference. The chart again confirmed that formulas S2 and S3 are the most preferred by consumers (80-100%). It is because the products possessed delicious and characteristic taste. Meanwhile, the formulas S1 (0-20%) and S4 (40-60%) have low consumer acceptability.

Energy value

The total calories of all samples were determined (Table 4). The calorie content of the four soup recipes varied between 94.0 and 94.5 kcal/100 g. According to the USDA's general calorie guidelines (U.S. Department of Agriculture, 2020), 40 kcals from the product is low, 100 kcals is medium, and 400 kcals or more is high based on a 2,000-calorie diet.Acceptable Macronutrient Distribution Range (AMDR) refers to the recommended intake range for a macronutrient. A balanced contained macronutrient distribution can help reduce the risks of diseases. A healthy diet also consists of selecting a variety of nutritious foods that supply a broad spectrum of nutrients (vitamins and minerals) and phytonutrients/bioactive chemicals (anthocyanins and -carotene). The AMDR for the energy distribution of carbohydrates, fats, and proteins in the diet is 45–65%, 20–35%, and 10–30% of energy intake, respectively (Thompson & Manore, 2017).

With the four formulas designed in this study, the percentage of energy supply from protein (19.32 to 19.58%) and lipid (9.34 to 9.62%) are lower. In comparison, the energy supply rate from carbohydrates is higher than AMDRs (71.06 to 71.08%). In addition to reducing the risk of chronic disease, AMDRs for a particular energy source provide critical nutrients.On the other hand, an input outside of the AMDR can lead to an increased risk

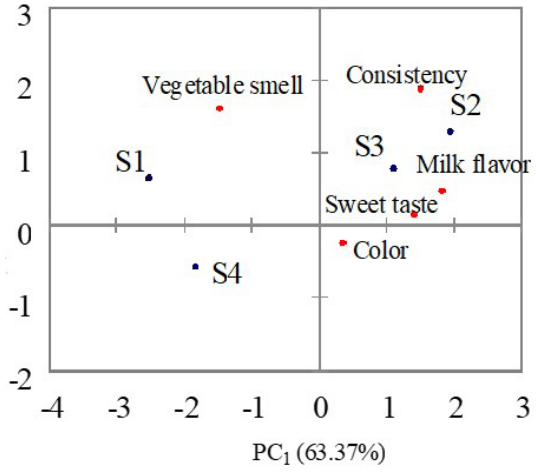

Figure 3. Correlation of sensory attributes with different soup formulas.

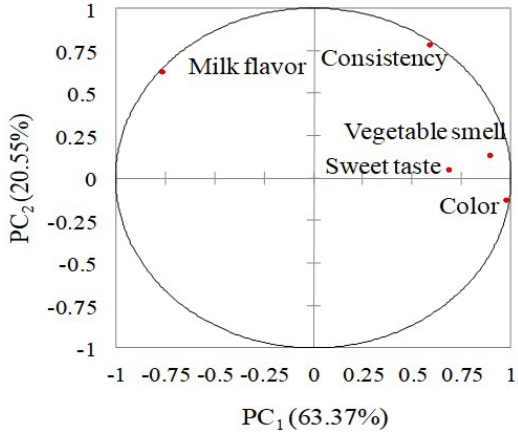

Figure 2. The distribution of sensory attributes according to the panelist's evaluation.

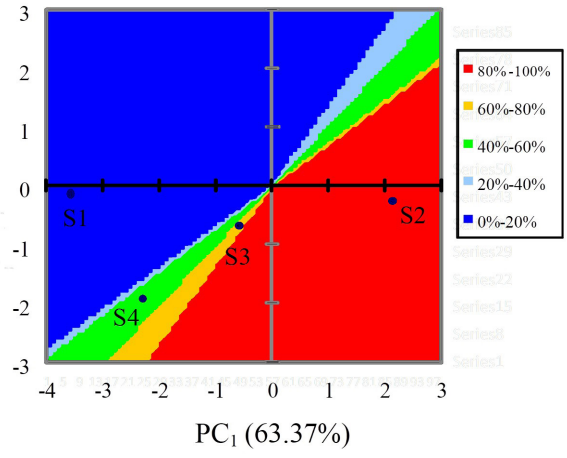

Figure 4. Preference mapping of mixed soup with different formulas.

Table 4. Energy-yielding nutrients and percentage of energy provided from macronutrients (for 100 gr cooked soup).

Formulas	Energy–yielding macronutrients (kcal)			Total calories	Percentage of energy supply from macronutrients (%)			Total (%)
	Protein	Carboh-ydrate	Lipid		Protein	Carboh-ydrate	Lipid	
S1	18.4	66.8	8.8	94.0	19.58	71.08	9.34	100
S2	18.4	66.9	8.9	94.2	19.49	71.08	9.43	100
S3	18.3	67.0	9.0	94.3	19.41	71.07	9.52	100
S4	18.3	67.1	9.1	94.5	19.32	71.06	9.62	100

Table 5. Nutritionalcomposition and estimated PRAL of ingredients used in soup making and product in different formulas.

Ingredients	Nutritional compositions (per 100 g of edible portion)						PRAL**			
	Pro. (g)	P (mg)	K (mg)	Ca (mg)	Mg (mg)	PRAL*	S1	S2	S3	S4
PSP flour	2.52	21.71	561.21	47.56	66.2	**-11.81**	-5.91	-5.61	-5.32	-5.02
OFSP flour	2.35	40.25	1226.5	45.5	125.7	**-26.40**	-2.64	-3.30	-3.96	-4.62
Potato starch	2.14	55	417	13	23	**-6.26**	-0.50	-0.38	-0.25	-0.13
Banana	1.09	22	358	5	27	**-6.77**	-0.34	-0.47	-0.61	-0.75
Mushroom	4.6	59	318	2	9	**-2.37**	-0.19	-0.19	-0.19	-0.19
Peas	5.42	108	244	25	33	**0.42**	0.01	0.01	0.01	0.01
Pumpkin	1	19	430	23	17	**-8.37**	-0.42	-0.42	-0.42	-0.42
Plant-based organic protein*	60.76	630	174	152	0	**47.29**	2.36	2.36	2.36	2.36
Fat filled milk powder*	26	750	250	100	0	**33.78**	2.03	2.03	2.03	2.03
Freeze-dried chicken meat	90	196	255	11	28	**45.06**	4.06	4.06	4.06	4.06
Water	0	0	0	3	1	**-0.06**	-0.13	-0.13	-0.13	-0.13
Total:							**-1.66**	**-1.91**	**-2.28**	**-2.66**

Note: All nutritional data of used ingredients derived from NutritionData (2022). *Data was calculated based on the ingredients nutrition profile; **Data was calculated as equation follows: [$PRAL_{ingredient}$(per 100 g) x amount of raw material (g)]/100.

of chronic diseases and inadequate nutritional intake. Therefore, it is necessary to take steps to improve to create products with better nutritional value and suitable for users.

Estimation of Potential Renal Acid Load (PRAL) of soups from blend recipes

The results showed that the PRAL values of PSP flour, OFSP flour, potato starch, banana, and pumpkin are negative (-), which are pretty alkaline ingredients (PRAL<0) (Table 5). Because of the majority in the formula, they gave the estimated PRAL values all negative, from formula S1 to S4 being -1.66, -1.91, -2.28, and -2.66 (PRAL<0), respectively. After digesting food, excess acid in the body needs to be filtered and put into the kidney's renal solute load; the more alkaline your diet, the lower your acid levels. So, following an alkaline diet can lower the kidneys' pressure. Effecting calcium and citrate metabolism, a PRAL in the diet and lower vegetable consumption are also connected with an increased risk of calcium renal stone development (Trinchieri et al., 2013). It is also essential for patients and the elderly when these bodily functions are impaired.With their alkaline qualities, all four soups have the potential to supplement the human diet with health benefits such as a reduced pancreatic cancer risk (Shi et al., 2021).

3.3 Effect of the addition of freeze-dried chicken meat on energy distribution in all recipes

By the combination of all the results obtained from the analysis of nutrients/phytonutrients, color, texture, PRAL score, and sensory values, the formula S2 (PSP flour 47.5%, OFSP flour 12.5%, potatoes 6%, banana 7%, mushroom 8%, petit poise 3%, pumpkin 5%, plant-based organic protein 5% and fat-filled milk powder 6%) was selected for the follow-up study. Chicken is an excellent source of protein, niacin, selenium, and phosphorus (Wu, 2016; Shreenath et al., 2020). Including chicken in your diet can aid in weight loss, muscle development, and bone health (Chijioke et al., 2020). For this reason, freeze-dried chicken is selected to adjust the recipe to make a product with high nutritional value, increasing protein and fat while reducing the carbohydrate content. The obtained results showed a good improvement in the protein and lipid content of the formulations. The energy distribution percentage from protein and lipid increasedfrom 20 to 27% and 9 to 11%, respectively, when the freeze-dried chicken was added to the S2 formula (Table 6). Increasing protein content promotes immune health (Kambarova et al., 2021), the formation of antibodies to fight infections, and the transport nutrients (Thompson & Manore, 2017). People who need more protein are children, patients undergoing treatment, patients recovering from illness, and the elderly (Yeung et al., 2017).

It has a high meaning in community service, especially for women with little time for meal preparation. Moreover, nutritious and convenient products can quickly serve patients when the country has a prolonged COVID epidemic.

Although the increase in lipids has not yet reached the AMDR (still lower), it also shows the excellent potential of this product

Table 6. Effect of added different freeze-dried chicken content on the energy distribution of the final product (using formula S2).

Freeze-dried chicken (%)	Protein (%)	Carbohydrate (%)	Lipid (%)	Total (%)
9*	20	71	9	100
11	21	69	10	100
13	23	67	10	100
15	24	65	10	100
17	26	64	10	100
19	27	62	11	100

*Percentage of the total mass of ingredients added to a recipe.

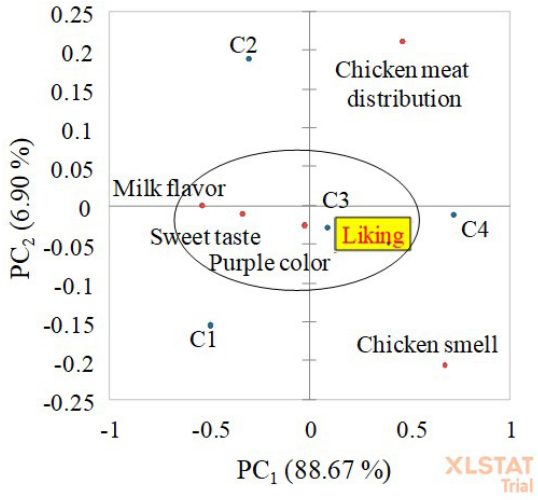

Figure 5. Principal Component Analysis (axes PC_1 and PC_2) of mixed soup with different freeze-dried chicken meat (C1: 13%, C2: 15%, C3: 17%, and C4: 19%).

Table 7. Nutrition facts (macronutrients, micronutrients, and percent Daily Value) of 200g of nutritious soup made from purple sweet potatoes supplemented with other vegetables and chicken meat.

Serving size: 200 g		
Calories: 188.4 Calories from fat: 17.8		
	% Daily Value*	
Total fat	2.08 g	3.2%
Trans fat	0 g	
Sodium	81.98 mg	3.42%
Total Carbohydrate	32.94 g	10.98%
Dietary fiber	2.46 g	9.84%
Protein	10.16 g	
Vitamin A	0.03 mg	20.03%
Calcium	57.72 mg	5.25%
Vitamin C	6.08 mg	10.14%
Iron	1.23 mg	8.76%
Potassium	263.56 mg	7.53%

*The % DV represents the number of nutrients in one serving that contributes to a daily diet with general nutritional advice for 2,000 calories per day.

Figure 6. Sweet potato soup prepared with chicken and other vegetables (Formula S2).

for the elderly, patients, and overweight people. If people want to increase the number of lipids, they can combine them with full-fat milk drinks to increase the fat content of the diet. Meanwhile, the increased range of dried chicken (from 9 to 19%) reduced the energy distribution from carbohydrates (from 71 to 62%). However, samples supplemented with 9 to 11% dried chicken still had a reasonably high carbohydrate energy distribution, and samples increased with 13 to 19% gave carbohydrate values around the recommended AMDR value (reached a 65%). Therefore, two pieces with 9 and 11% of dried chicken meat were excluded, and four samples with dried chicken meat of 13 to 19% were selected for sensory evaluation. CATA examined the obtained Data with the XLSTAT software (Figure 5), which showed the panelists' Liking qualities for samples. It was noted that the panelists favored purple color, sweet flavor, and milk flavor. Soup (formula S2) containing 15% more freeze-dried chicken passed the sensory requirements for color, odor, flavor, and density of chicken in the product (Figure 6).

3.4 The nutrients facts of serving size

The nutrition facts (200 g of serving size) and percent Daily Value (%DV) were determined (Table 7). For people who require about 2000 kcal/day, this nutritional product (energy provides approx. 188.4 kcal) can ensure a part of the energy supply for meals. The %DV is used to determine how high or low a unique nutrient content (considered essential to human nutrition) is per serving size as stated in the Table 7. As a general guideline, a %DV less than or equal to 5% (for each nutrient in each serving) is considered low, and %DV values of 20% or more are considered high (Thompson & Manore, 2017). The calculated %DV showed

less fat and sodium per serving (%DV<5). Total carbohydrates, fiber, vitamin A, calcium, vitamins C, Iron, and potassium seem pretty good (%DV between 5 and 20%). The product from the S2 formula can meet the nutritional requirements of different age groups and sexes, especially the elderly, patients, or in the recovery period. Remember that consuming a balanced diet and indulging in regular physical activity are essential, and that eating foods rich in nutrients as opposed to energy is the greatest approach to maintain your health.

4 Conclusions

Based on chemical, and sensory evaluation, nutritional characteristics analysis, energy balance, and high acceptability, the purple sweet potato could be combined with other plant and animal ingredients to create a new, convenient soup product with high nutritional value. Soup is rich in protein, carbohydrates, ash, fiber, anthocyanin, and -carotene, but low in fat and calories. Therefore, the currently produced PSP soup is an appropriate option for meeting the nation's nutritional needs. It could also reduce protein-energy malnutrition in our country. Formula S2 of PSP soup combinations supplemented with 15% freeze-dried chicken had enough levels of the necessary nutrients and could be scaled up. This product is also considered nutrient-dense food, providing more nutrients/bioactive compounds and other health-promoting components without added sugars. It also showed valuable for designing the product in the future which may enlarge the manufacturing of healthy soup with high consumer acceptance.

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