https://doi.org/10.21603/2074-9414-2023-3-2449
https://elibrary.ru/GIJOTA

Original article
Available online at https://fptt.ru/en

Pempek Fishcake from *Channa micropeltes* with Pumpkin Puree: Quality Assessment

Rabiatul Adawyah, Tri Dekayanti, Ainun Aslamiah, Muhammad Wahyu AS, Findya Puspitasari*

Lambung Mangkurat University, Banjarmasin, Indonesia

Received: 04.01.2023
Revised: 24.01.2023
Accepted: 07.02.2023

**Findya Puspitasari: findya.puspitasari@ulm.ac.id, https://orcid.org/0000-0002-6224-6095*
Rabiatul Adawyah: https://orcid.org/0000-0003-0673-0568
Tri Dekayanti: https://orcid.org/0000-0002-7001-0779
Ainun Aslamiah: https://orcid.org/0000-0001-7283-6534
Muhammad Wahyu AS: https://orcid.org/0000-0002-0020-8296

Abstract.
Pempek is an authentic traditional dish of Indonesian cuisine. As a popular food, it needs to be both tasty and nutritious. Mashed pumpkin can add some health-beneficial properties to the traditional pempek and reduce its carbohydrate content. This research featured pempek made of farmed toman fish (*Channa micropeltes*), which is an affordable raw material. The research objective was to evaluate the consumer acceptance of the experimental pempek based on its sensory assessment and a folding test. This research also revealed the proximate composition, *β*-carotene, and amino acids in the pempek samples.
The research procedure included the following stages: making pumpkin puree; making pempek by substituting tapioca flour with pumpkin puree (control: 0%, Formulation 1: 10%, Formulation 2: 20%); sensory assessment and folding test; proximate analysis; *β*-carotene analysis; and amino acid analysis.
A greater proportion of pumpkin puree improved the appearance, color, aroma, flavor, and texture values of the experimental sample. Based on the folding test, the elasticity of pempek decreased as the pumpkin share increased. Pumpkin puree improved the quality of pempek in terms of its protein, moisture, ash, carbohydrate, *β*-carotene, and amino acid composition. Formulation 2 with 20% of tapioca flour substituted with pumpkin puree showed the best results for protein (7.91%) and amino acids (10.27%), as well as the lowest carbohydrate content (26.76%).
Mashed pumpkin proved to be an excellent substitute of tapioca flour in the traditional Indonesian pempek fishcake as it improved both its sensory profile and nutritional value.

Keywords. Giant snakehead, *Channa micropeltes*, toman fish, pempek, pumpkin, nutritional value, *β*-carotene, amino acids

Funding. The authors received the DIPA Fund of Lambung Mangkurat University (LMU) in 2022 (No. SP DIPA - 023.17.2. 6777518/2022), according to Chancellor's Decree No. 458/UN8/PG/2022, LMU and Ministry of Education, Culture, Research and Technology, Republic of Indonesia.

For citation: Adawyah R, Dekayanti T, Aslamiah A, Wahyu AS M, Puspitasari F. Pempek Fishcake from *Channa micropeltes* with Pumpkin Puree: Quality Assessment. Food Processing: Techniques and Technology. 2023;53(3):465–474. https://doi.org/10.21603/2074-9414-2023-3-2449

https://doi.org/10.21603/2074-9414-2023-3-2449
https://elibrary.ru/GIJOTA

Оригинальная статья
https://fptt.ru

Качество рыбных котлет «пемпек» из змееголова красного (*Channa micropeltes*) с тыквенным пюре

Р. Адавиа, Т. Декаянти, А. Асламиа, М. Уахью, Ф. Пуспитасари*

Университет Ламбунг Мангкурат, Банджармасин, Индонезия

Поступила в редакцию: 04.01.2023
Принята после рецензирования: 24.01.2023
Принята к публикации: 07.02.2023

**Ф. Пуспитасари: findya.puspitasari@ulm.ac.id, https://orcid.org/0000-0002-6224-6095*
Р. Адавиа: https://orcid.org/0000-0003-0673-0568
Т. Декаянти: https://orcid.org/0000-0002-7001-0779
А. Асламиа: https://orcid.org/0000-0001-7283-6534
М. Уахью: https://orcid.org/0000-0002-0020-8296

Аннотация.
Пемпек – традиционное блюдо индонезийской кухни, представляющее собой рыбные котлеты с добавлением муки из тапиоки. Тыквенное пюре может придать традиционному пемпеку питательные свойства и снизить содержание углеводов, поскольку популярные у населения продукты питания должны быть не только вкусными, но и полезным. Цель исследования заключалась в оценке качества пемпека, приготовленного по разработанной рецептуре из более доступного, чем традиционное сырье, и выращенного искусственным способом змееголова красного (*Channa micropeltes* или томан) с добавлением тыквенного пюре.
Исследование включало следующие этапы: подготовка тыквенного пюре; приготовление пемпека путем замены муки из тапиоки тыквенным пюре (контроль: 0 %, рецептура 1: 10 %, рецептура 2: 20 %); органолептическая оценка и испытание на перегиб; анализ компонентного и аминокислотного составов; определение содержания β-каротина.
Увеличение доли тыквенного пюре улучшило внешний вид, цвет, аромат, вкус и текстуру экспериментального образца. Испытания на перегиб показали, что эластичность пемпека снижалась по мере увеличения доли тыквенного пюре. Введение в рецептуру пемпека тыквенного пюре повысило качество блюда по таким аспектам, как содержание белка, влаги, золы, углеводов и β-каротина, а также аминокислотный состав. Рецептура 2, в которой 20 % муки из тапиоки было заменено тыквенным пюре, показала лучшие результаты по белку (7,91 %) и аминокислотам (10,27 %), а также наименьшее содержание углеводов (26,76 %).
Экспериментальное блюдо из филе *C. micropeltes* с добавлением тыквенного пюре получило более высокую органолептическую оценку, чем традиционные рыбные котлеты «пемпек». Его пищевая ценность оказалась выше. Исследование показало, что тыквенное пюре может успешно заменить муку из тапиоки в традиционных индонезийских рыбных котлетах «пемпек».

Ключевые слова. Гигантский змееголов, *Channa micropeltes*, рыба томан, пемпек, тыква, пищевая ценность, β-каротин, аминокислоты

Финансирование. Исследование выполнено за счет гранта Фонда DIPA Университета Ламбунг Мангкурат в 2022 г. (№ СП ДИПА – 023.17.2.6777518/2022, приказ ректора № 458/UN8/PG/2022) и Министерства образования, культуры, исследований и технологий Республики Индонезия.

Для цитирования: Качество рыбных котлет «пемпек» из змееголова красного (*Channa micropeltes*) с тыквенным пюре / Р. Адавиа [и др.] // Техника и технология пищевых производств. 2023. Т. 53. № 3. С. 465–474. (На англ.). https://doi.org/10.21603/2074-9414-2023-3-2449

Introduction

Pempek is an authentic traditional food from Indonesia. It is especially popular in South Sumatra. As a rule, pempek was made of belida fish or mackerel. However, these types of fish were rare and expensive, and people started looking for an alternative raw material [1]. Snakehead, skipjack, eel, catfish, and some freshwater fish are a few of scientifically proven less expensive alternatives [2–6].

In South Kalimantan, Indonesia, pempek is made from giant snakehead fish, known in the region as *toman*. Toman is omni-seasonal and, as a result, more affordable. In addition, toman can be farmed: in 2017, the production of toman fish rose from 5 to 9 tons [7]. Toman farming grows in line with its use as a raw material for semi-finished pempek. We chose toman fish for our research because it has white meat and a substantial amount of protein. As a result, it jellify-ies quite easily, thus giving pempek its characteristic texture. Fitriyani *et al.* reported that toman fish was rich in protein (24.75%) [8]. In addition, albumin protein in toman fish is beneficial for health [9, 10].

Pempek is one of the most popular dishes of Indonesian cuisine, second only to rendang and meatballs. The market price of pempek is quite reasonable and ranges from 1000 to 20 000 Indonesian rupiahs, depending on the size and type [11]. However, the traditional pempek formulation includes tapioca flour, which is notorious for its high amylopectin content. Syamsir *et al.* reported that tapioca starch had 48–50% amylopectin [12]. Amylopectin-rich starch in human diet can cause obesity. Burke proved that excessive consumption of amylopectin caused weight gain, indigestion, diarrhea, rash, and flatulence [13]. Therefore, it is necessary to find alternative materials to substitute tapioca flour in the traditional pempek.

Pumpkin has numerous health benefits: not only does it contain antioxidant vitamins and minerals, but it also reduces digestive disorders and is known to prevent diabetes and cancer [14, 15]. Pumpkin was reported to contain carotenoids (*β*-carotene, lutein, lycopene), polyphenols, flavonoids, polysaccharides, pectin, and dietary fiber [16–19]. The content of polysaccharides and dietary fiber in pumpkin is good for anti-diabetic diets. Therefore, the last decade has seen many studies that used pumpkin to fortify biscuits, biscuits for babies, analog rice, flakes, and bread [20–25]. Pumpkin is used as flour or puree that is easy to mix with other food ingredients. In this research, we evaluated the consumer acceptance of pumpkin-substituted pempek based on the hedonic scale and a folding test. In addition, the experimental pempek also underwent a proximate analysis and was tested for *β*-carotene and amino acids.

Study objects and methods

Pumpkin puree. The pumpkin was washed, peeled, and cleaned from seeds. It was then cut into several pieces, which were steamed at 100°C for 10 min. The resulting pulp went through a food processor until it reached a puree texture.

Toman fish pempek. Toman fish was scaled and washed thoroughly, then filleted to separate the flesh from the skin and bones. The resulting fillet was mashed in a food processor. After that, we mixed it with spices and tapioca flour until homogeneous. The pumpkin puree was added in the proportions specified in Table 1 and mixed until homogeneous. After giving it a traditional elongated shape (*lenjer*), we steamed it at 100°C for 10 min.

Table 1. Formulations of toman pempek with pumpkin puree

Таблица 1. Рецептуры рыбных котлет «пемпек» из *Channa micropeltes* и тыквенного пюре

Ingredients	Treatments		
	Control	Formulation 1 (10%)	Formulation 2 (20%)
Toman fillet, g	300.0	300.0	300.0
Pumpkin puree, g	0	10.0	20.0
Tapioca flour, g	100.0	90.0	80.0
Salt, g	7.5	7.5	7.5
Garlic, g	15.0	15.0	15.0
Water, mL	110.0	110.0	110.0

Sensory assessment and folding test. The samples were tested for appearance, color, aroma, flavor, and texture on a hedonic scale from 1 to 9 as stated in Indonesian National Standard No. 01 2346-2006 Instructions for organoleptic and or sensory testing. The scores were as follows: like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), and dislike extremely (1). The folding test defines the quality of fish-based gel. We carried it out by cutting pempek into thin (3 mm) slices. The panelists placed a slice between their thumb and forefinger and folded. After that, the piece was examined for cracks. The maximal score was five [26]. The sensory assessment and the folding tests involved six certified trained panelists from the Fisheries Product Quality Implementation Center, South Kalimantan, Indonesia.

Proximate analysis. The proximate test included a gravimetric measuring of the moisture content based on Indonesian National Standard No. 2973:2018 Biscuits. The ash and fat content were also measured gravimetrically, while the protein content was studied titrimetrically. The carbohydrate content followed Indonesian National Standard No. 01-2891-1992 How to test food and beverages [27].

***β*-carotene analysis.** The *β*-carotene test involved the method of high-performance liquid chromatography (HPLC) in a Hewlett Packard 1050 device with a 151 UV/VIS detector and a shim-pack VP ODS column 5 m 150×4.6 mm. The mobile phase was 60 mL of methanol (1 g/L BHT). The flow rate was 1.0 mL/min, and the column temperature was 24°C. *β*-carotenes were detected at 450 nm and quantified using calibration curves obtained for each standard, both separately and as a mix [28].

Amino acid analysis. The amino acid composition was detected using HPLC (Shimadzu) as described by Rieuwpassa *et al.* [29]. The solid and liquid samples were 0.5 g and 0.5 mL, respectively. The amino acid standard solutions were prepared in standard series of 0, 1, 5, 10, 25, and 50 using 25 mL of distilled water.

The reagents included orthophthaldehyde (OPA), trisodium citrate pH 3.25 (as the mobile phase), HCl 6 N, HCl 1 N, and HCl 0.01 N. The amino acid test relied on a HPLC device with a Shim-pack VP ODS column of 5 m 150×4.6 mm, a CTO 10 ASVP column oven, a RF20 Fluorescence detector, and the following test conditions: run time = 30 min, wavelength = 450 nm, flow rate = 1 mL/min, injection volume = 10 µL. The results were processed using LabSolution 5.6.1 for Windows.

Results and discussion

Figure 1 illustrates the sensory profile of the samples. The score for color, aroma, flavor, and texture increased together with the share of pumpkin puree, only the appearance value remained the same.

The pumpkin did not affect the appearance presumably because its percentage was as low as 10–20%. This was in line with the results obtained by Pongjanta, where 10–20% pumpkin flour had no effect on the appearance of cookies [25]. In contrast to appearance, other parameters, i.e., color, aroma, flavor, and texture, increased in value as the percentage of pumpkin puree in the formulation grew. Formulation 1 with 20% of pumpkin puree obtained the highest value compared to the control treatment (0%) and Formulation 1 with only 10% of pumpkin puree. The color changed due to the yellow-orange pigment in β-carotene [17, 23, 30]. Zuraida and Supriati confirmed that pumpkin contained 80% β-carotene [31]. As a result, pumpkin inevitably affects the color of food.

Aroma is usually interpreted as a combination of smell and flavor resulting from the evaporation of particular compounds in the product [32]. Figure 1 shows that Formulation 2 with 20% of pumpkin puree had a higher preference value than the control sample (0%) and Formulation 1 (10%). According to [23], pumpkin flour emits a distinctive caramel aroma no other flour possesses. The panelists liked this aroma so much that the aroma score grew together with the pumpkin pu-ree percentage. In addition to aroma, flavor also determines the quality of food products. According to Fadhalah *et al.*, pempek owes its flavor, which appears after thermal processing, to the amino acids contained in fish [1]. Pempek with 20% of pumpkin puree had a higher preference value than the control sample (0%) and Formulation 1 (10%). The panelists' preference for pempek with pumpkin puree was due to an increase in the carbohydrate content in the pumpkin when heated [33]. This result was in line with the findings reported by Pranomo *et al.*, who proved that pumpkin could improve the flavor profile of the final product [23].

Texture shows the appearance, shape, condition, and softness of food whether dry, wet, or moist [34]. The texture of the experimental pempek was more preferable than that of the control sample (0%). Formulation 2 with 20% of pumpkin puree received a higher score than Formulation 1 with only 10%. In general, the texture of pempek depends on the type of fish because of gelatinization. Pumpkin puree improved the jellifying properties of the experimental samples due to its good water absorption properties [35, 36].

Pempek is a product made from fish protein, and its physical quality is measured by the level of elasticity. Usually, jellified dishes, such as meatballs and pempek, are tested for elasticity using the folding test method. According to Ririsanti *et al.*, the main purpose of the folding test is to determine the level of elasticity in a product [37]. Figure 2 illustrates the results of the pempek folding test.

Pumpkin puree reduced the elasticity of the experimental pempek samples. The control sample had a value of 5, while Formulations 1 and 2 with 10 and 20% of pumpkin puree, respectively, had only 4. The elasticity of pempek depends on myofibril protein in fish and amylopectin in tapioca flour [1, 38, 39]. The

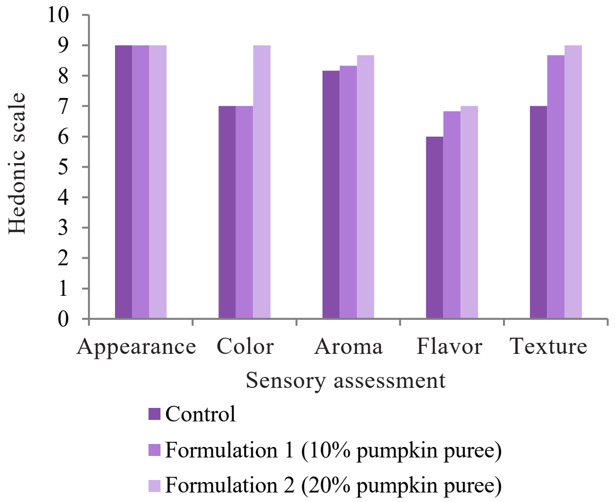

Figure 1. Sensory assessment of pempek with pumpkin puree

Рисунок 1. Органолептическая оценка рыбных котлет «пемпек» из *Channa micropeltes* и тыквенного пюре

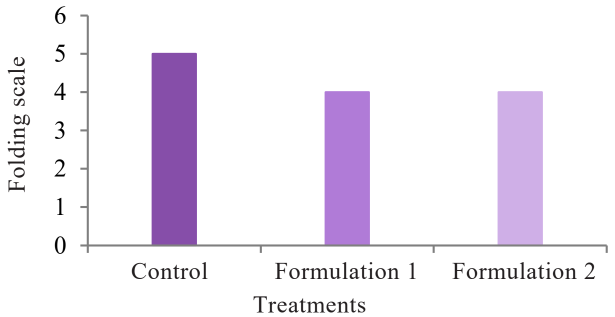

Figure 2. Folding test of pempek with pumpkin puree

Рисунок 2. Испытание на перегиб рыбных котлет «пемпек» из *Channa micropeltes* и тыквенного пюре low elasticity of the experimental pempek samples was due to the reduced amount of tapioca flour. According to Aminullah *et al.*, amylopectin in tapioca flour could increase the elasticity of pempek [5]. Pumpkin has no amylopectin but it does contain amylose. Pereira *et al.* reported that pumpkin flour contained 0.9–3.0% amylose [40]. According to Simpson, starch that is rich in amylopectin gave the final product good jellifying properties, while starch with amylose resulted in a stiff gel [41].

The proximate analysis defined the chemical profile of the experimental pempek. Pumpkin puree was able to increase the protein content ($p < 0.05$) (Table 2) because pumpkin contained more protein than tapioca flour [25, 40]. Hence, substituting pumpkin with tapioca flour also affected the protein content of pempek. In fact, the protein content of toman pempek with pumpkin puree was 5–6 times higher than that of its traditional analogue obtained from the Palembang market. Pempek producers tend to reduce the share of fish in the formulation to make the production more economical; they replace fish with other protein sources, e.g., wheat flour, which lowers the protein value [8]. According to previous research, the selling price of pempek affected consumer buying decisions [11].

Moisture content determines the shelf life of a product. Pumpkin puree affected the moisture content ($p < 0.05$). Formulation 2 with 20% of pumpkin puree had the highest moisture content and was significantly different from Formulation 1 with 10% of pumpkin puree and the control sample. The moisture content increased because pumpkin mash has a quite high-water content [45]. Ratnawati *et al.* also reported that adding pumpkin to biscuits increased the moisture content [22].

Ash content is an inorganic component contained in a material. Pumpkin puree also affected the ash content ($p < 0.05$). Formulation 2 with 20% of pumpkin puree had the highest ash content compared to the control and Formulation 1 (10%). Since the ash content in fresh pumpkins is 1.25–10.53%, it also increased the ash content in the experimental pempek [42, 45]. Similarly, pumpkin was able to increase the ash content in biscuits, analog rice, and cake [22, 23, 45]. The ash content revealed the presence of minerals contained in the pumpkin. According to Adebayo *et al.*, pumpkin pulp contains Na, K, Mg, Ca, Mn, Fe, Cu, Ni, P, and Pb [46].

The substitution of tapioca flour with pumpkin puree had a significant effect ($p < 0.05$) on the decrease in carbohydrates. Both experimental formulations had a lower content of carbohydrates than the control. The decrease in carbohydrate content in the experimental pempek contrasted with the protein content because pumpkin has less carbohydrate than tapioca flour [42, 43]. As reported by Ratnawati *et al.* and Pranomo *et al.*, pumpkin could reduce the amount of carbohydrates in analog biscuits and rice [22, 23]. Moreover, pumpkins only contained 10.51–43.39% carbohydrates [25, 42]. In fact, a certain polysaccharide in pumpkin was found health-beneficial and could ward off free radicals if appropriately consumed [47].

Fat is a component of essential macronutrients. Pumpkin puree had no significant effect ($p > 0.05$) on the fat content of the final product. Pumpkins have very little fat, 0.89–1.45% [25, 42]. In this respect, our research confirmed the results obtained by Ratnawati *et al.* and Pramono *et al.*, who reported that pumpkin substitution did not increase fat content in analog rice and biscuits [22, 23].

β-carotene is a carotenoid compound found in pumpkin. This compound is a precursor for the formation of vitamin A in the human body [14]. It is to be found in vegetables and fruits, e.g., carrots, pumpkins, sweet potatoes, etc. Pumpkin-fortified products have a better nutrition value. In our research, pumpkin puree fortified pempek with β-carotene (Fig. 3).

Figure 3 shows that the amount of β-carotene in pempek correlated with the share of pumpkin puree. Pongjanta *et al.* also reported that pumpkin was able to increase the content of β-carotene in the finished product [25]. Dhiman *et al.* found 11.2 mg β-carotene per 100 g of finished product while Kim *et al.* reported 1.48–17.04 mg/kg [42, 48]. β-carotene in pumpkin is a natural antioxidant that protects the body from free radicals brought about by oxidation [14].

Table 2. Proximate analysis of pempek with pumpkin puree

Таблица 2. Компонентный состав рыбных котлет «пемпек» из *Channa micropeltes* и тыквенного пюре

Parameters, %	Pempek			Pumpkin puree [42]	Tapioca flour [43]	Pempek [44]
	Control	Formulation 1 (10% pumpkin puree)	Formulation 2 (20% pumpkin puree)			
Protein	7.55 ± 011^{a}	7.82 ± 0.13^{b}	7.91 ± 0.07^{b}	11.31	8.28	0.50–1.20
Moisture	51.17 ± 1.03^{a}	55.05 ± 0.72^{b}	62.35 ± 0.24^{c}	840.40	12.49	56.00–63.57
Ash	1.38 ± 0.15^{a}	1.40 ± 0.75^{a}	1.75 ± 0.10^{b}	10.53	1.52	1.00–4.14
Carbohydrate	38.84 ± 1.06^{a}	34.45 ± 0.80^{b}	26.76 ± 0.14^{c}	43.39	75.99	27.00–33.02
Fat	1.05 ± 0.03^{a}	1.23 ± 0.08^{a}	1.23 ± 0.13^{a}	0.89	1.72	1.00–1.37

Different superscript letters (a, b, c) mark significantly different results ($p < 0.05$).

Надстрочные буквы (a, b, c) обозначают разные результаты ($p < 0,05$).

Oxidation is caused by bad eating habits, resulting in various diseases and obesity. A diet with lots of antioxidant foods may reduce obesity. Pumpkin can be an excellent component of any anti-obesity diet because it has a reasonably low carbohydrate content and little protein, which also contains enough amino acids. A diet that presupposes lots of β-carotene could reduce heart disease and cancer morbidity as well as increase immunity and protection from free radicals [49].

Fish protein is the primary nutritional source of pempek. The quality of protein depends on the amount and composition of its amino acids. Table 3 shows the amino acid profile of the experimental pempek.

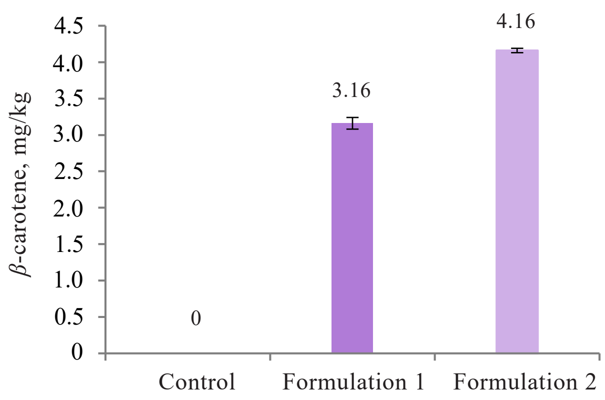

Figure 3. β-carotene in pempek with pumpkin puree

Рисунок 3. Содержание β-каротина в рыбных котлетах «пемпек» из *Channa micropeltes* и тыквенного пюре

Table 3 shows the amino acid content in pempek made of pumpkin puree, tapioca flour, and toman fish. Pumpkin puree affected the amino acid content. Formulation 2 with 20% of pumpkin puree showed the best results for amino acids (10.27%) whereas the control sample had only 7.53%. In previous studies, pumpkin puree was found to contain nine types of essential amino acids and six types of non-essential amino acids [42]. Toman fish was reported to contain ten essential amino acids and six non-essential amino acids [8]. Tapioca starch is known to contain eight essential amino acids and nine non-essential amino acids [43, 50].

Table 3 shows that leucine and valine were the dominating essential amino acids in pempek with pumpkin puree, which is in line with some other publications [42]. Leucine is essential for energy production, especially in controlling protein synthesis [51]. It promotes brain function, stabilizes blood sugar levels, and facilitates bone, muscle, and skin healing [52–54]. Valine functions in the nervous and digestive systems. It helps against neuromuscular, mental, and emotional disorders, insomnia, and nervous states [55]. Valine also stimulates muscle coordination, helps to repair damaged tissue, and maintains nitrogen balance [29].

Glutamic acid and arginine proved to be the dominant non-essential amino acids in pempek with pumpkin puree. Glutamic acid and arginine were reported as the dominant non-essential amino acids in pumpkin, toman fish, and tapioca flour. Glutamic acid gives a savory flavor to food products [56]. Arginine improves

Table 3. Amino acids in pempek with pumpkin puree

Таблица 3. Содержание аминокислот в рыбных котлетах «пемпек» из *Channa micropeltes* и тыквенного пюре

Amino acids	Pempek			Pumpkin puree, % [42]	Fresh toman fish, % [8]	Tapioca flour, % [43]
	Control	Formulation 1 (10% pumpkin puree)	Formulation 2 (20% pumpkin puree)			
Essential amino acids						
Isoleucine	0.35	0.38	0.43	0.71	0.95	0.33
Leucine	0.55	0.67	0.78	0.90	1.58	0.43
Lysine	0.19	0.25	0.26	0.43	1.93	3.00
Methionine	0.22	0.26	0.26	0.11	0.67	0.58
Phenylalanine	0.39	0.47	0.54	0.49	0.81	0.25
Tyrosine	0.19	0.22	0.26	0.26	0.67	0.71
Histidine	0.32	0.38	0.36	1.11	0.40	0.13
Threonine	0.25	0.29	0.33	0.28	0.83	1.49
Valine	0.48	0.56	0.58	0.73	0.97	0.15
Total	2.94	3.48	3.80			
Non-essential amino acids						
Alanine	0.36	0.43	0.49	0.77	1.14	6.11
Arginine	0.99	1.22	1.44	1.11	1.26	9.02
Aspartic Acid	0.73	0.83	0.99	2.21	2.06	0.39
Glutamic Acid	1.63	1.93	2.33	4.32	3.15	8.90
Glycine	0.41	0.48	0.57	0.12	0.88	0.29
Serine	0.47	0.59	0.65	0.36	0.74	0.30
Total	4.59	5.48	6.47			

semen quality and strengthens the immune system, as well as inhibits oxidative stress and tissue damage [57, 58]. In addition, arginine lowers blood pressure, improves blood circulation, reduces fat levels, and strengthens the heart muscle [59, 60]. Arginine can also stimulate hormone secretion and promotes wound healing [61, 62]. Pempek fortified with pumpkin proved to increase the amount of essential and non-essential amino acids.

In Indonesia, toman fish is part of a great diversity of processed foods. For instance, the residents of Kumba Village on the Indonesia-Malaysia border use it to cook fish nuggets [63]. Toman fish makes excellent fishballs with a soft texture, delicious taste, and characteristic smell [64]. It can serve as a raw material for biscuits with a protein content of 18% [65]. Indonesian cuisine knows pumpkin as a fortification ingredient in many foods, e.g., chicken sausages, wet noodles, and cakes [66–68]. Therefore, toman fish meat and pumpkin puree can definitely improve the nutritional value of traditional pempek.

Conclusion

Pumpkin puree proved to be an effective substitute for tapioca flour in toman fish pempek. It improved both the sensory profile and nutritional value of pempek in that it increased the contents of protein, β-carotene, and amino acids while reducing the amount of carbohydrates. Formulation 2 with 20% of pumpkin puree had the best results for consumer acceptance and nutritional quality.

Contribution

R. Adawyah and F. Puspitasari developed the research concept and design, interpreted the data, drafted the manuscript, and revised it. T. Dekayanti, A. Aslamiah, and M. Wahyu AS helped with data collection, edited the article, and made critical revisions. All the authors read and approved the final manuscript

Conflict of interest

The authors declare no conflict of interests regarding the publication of this article.

Acknowledgements

The authors would like to express their deepest gratitude to the Rector of Lambung Mangkurat University and the Dean of the Department of Fisheries and Marine for their support.

Критерии авторства

Р. Адавиа и Ф. Пуспитасари: концепция и план исследования, интерпретация данных, написание статьи и редактура. Т. Декаянти, А. Асламиа и М. Уахью: сбор данных, редактирование статьи. Все авторы прочитали и одобрили окончательный вариант рукописи.

Конфликт интересов

Авторы заявляют об отсутствии конфликта интересов.

Благодарность

Авторы выражают благодарность ректору Университета Ламбунг Мангкурат и декану факультета морского рыболовства.

References

1. Fadhallah EG, Nurainy F, Suroso E. Sensory, chemical and physical characteristic of pempek from barred mackerel and barracuda fish in various formulations. Jurnal Penelitian Pertanian Terapan. 2021;21(1):16–23. (In Indonesian).

2. Sugito S, Hayati S. The use of gabus (ophicepallus strianus blkr) fillet fish and application of freezing in making gluten pempek. Jurnal Ilmu-Ilmu Pertanian Indonesia. 2006;8(2):147–151. (In Indonesian).

3. Talib A, Marlena T. Organoleptic and chemical characteristics of skipjack tuna empek-empek products. Agrikan Jurnal Agribisnis Perikanan. 2015;8(1):50–59. (In Indonesian).

4. Rofiq M, Ernawati. The proportion of tapioca flour addition on the quality pempek old boiling fish eels (*Monopterus albus*). Teknologi Pangan: Media Informasi dan Komunikasi Ilmiah Teknologi Pertanian. 2017;8(1):9–16. (In Indonesian).

5. Aminullah, Daniel, Rohmayanti T. The texture and hedonic profiles of pempek lenjer made from local commodities of bogor taro flour (*Colocasia esculenta* L. Schott) and African catfish (*Clarias gariepinus*). Jurnal Teknologi and Industri Hasil Pertanian. 2020;25(1):7–18. (In Indonesian). https://doi.org/10.23960/jtihp.v25i1.7-18

6. Astuti MP, Haryati S, Subjatimah, M. Characteristic of empek-empek with different types of freshwater fish. Jurnal Mahasiswa, Food Technologi and Agricultural Product. 2021. (In Indonesian).

7. Ansyari P. Slamat. Food characteristics of Indonesian snakehead in Danau Panggang monotonous swamp, South Kalimantan. Warta Iktiologi. 2020;4(2):27–33. (In Indonesian).

8. Fitriyani E, Nuraenah N, Deviarni IM. Comparison of chemical composition, fatty acids, amino acids of toman fish (*Channa micropeltes*) and snakehead fish (*Channa striata*) from West Kalimantan waters. Manfish Journal. 2020;1(2):71–82. (In Indonesian). https://doi.org/10.31573/manfish.v1i02.121

9. Nurilmala M, Safithri M, Pradita FT, Pertiwi RM. Protein profile of striped snakehead (*Channa striata*), giant snakehead (*Channa micropeltes*), and marble goby (*Oxyeleotris marmorata*). Jurnal Pengolahan Hasil Perikanan Indonesia. 2020;23(3):548–557. (In Indonesian). https://doi.org/10.17844/jphpi.v23i3.33924

10. Asikin AN, Kusumaningrum I. Edible portion and chemical composition of snakehead fish from pond cultivation in Kutai Kartanegara Regency, East Kalimantan. Ziraa'ah. 2017;42(3):158–163. (In Indonesian).

11. Agustin A, Aishah A. Analysis of the effect of price on purchasing decisions at Pempek Pasar 26 ilir Palembang. Jurnal Pariwisata Darussalam. 2021;1(1):9–15. (In Indonesian).

12. Syamsir E, Hariyadi P, Fardiaz D, Andarwulan N, Kusnandar F. Characterization of tapioca from five varieties *Manihot utilisima* Crantz from Lampung. Jurnal Agroteknologi. 2020;5(1):93–105. (In Indonesian).

13. Burke M. Carbohydrate intolerance and disaccharidase measurement – a mini review. Clinical Biochemist Reviews. 2019;40(4):167–174.

14. Ceclu L, Mocanu DG, Nistor OV. Pumpkin – health benefits. Journal of Agroalimentary Processes and Technologies. 2020;26(3):241–246.

15. Habiba U, Robin MA, Hasan MM, Toma MA, Akhter D, Mazumder MAR. Nutritional, textural, and sensory quality of bars enriched with banana flour and pumpkin seed flour. Foods and Raw Materials. 2021;9(2):282–289. https://doi.org/10.21603/2308-4057-2021-2-282-289

16. Bergantin C, Maietti A, Tedeschi P, Font G, Manyes L, Marchett N. HPLC-UV/Vis-APCI-MS/MS determination of major carotenoids and their bioaccessibility from "Delica" (*Cucurbita maxima*) and "Violina" (*Cucurbita moschata*) pumpkins as food traceability markers. Molecules. 2018;23(11). https://doi.org/10.3390/molecules23112791

17. Seo JS, Burri BJ, Quan Z, Neidlinger TR. Extraction and chromatography of carotenoids from pumpkin. Journal of Chromatography A. 2005;1073(1–2):371–375. https://doi.org/10.1016/j.chroma.2004.10.044

18. Al-Anoos IM, El-dengawi RAH, Hasanin HA. Studies on chemical composition of some Egyptian and Chinese pumpkin (Cucurbita maxima) seed varieties. Journal of Plant Science and Research. 2005;2(2).

19. McCreight JD. Cultivation, and uses of cucurbits. In: Grumet R, Katzir N, Garcia-Mas J, editors. Genetics and genomics of cucurbitaceae. Cham: Springer; 2017. pp. 1–12. https://doi.org/10.1007/7397_2016_2

20. Kulkarni AS, Joshi DC. Effect of replacement of wheat flour with pumpkin powder on textural and sensory qualities of biscuit. International Food Research Journal. 2013;20(2):587–591.

21. Miranti MG, Kristiastuti D, Kusumasari ED. Formulation of biscuit using yellow pumpkin flour and the addition of coconut flour as an alternative for complementary feeding. Journal of Agro Science. 2019;7(1):41–47. https://doi.org/10.18196/pt.2019.092.41-47

22. Ratnawati L, Indrianti N, Ekafitri R, Mayasti NKI. The effect of addition pumpkin and carrot puree on the physicochemical and textural properties of mocaf biscuit as complementary food. IOP Conference Series: Earth and Environmental Science. 2021;733. https://doi.org/10.1088/1755-1315/733/1/012120

23. Pramono YB, Nurwantoro, Handayani D, Mulyani S, Wibowo CH. Physical, chemical, stickiness, and organoleptic characteristics of analog white sweet potato rice with the addition of pumpkin flours. IOP Conference Series: Earth and Environmental Science. 2021;803. https://doi.org/10.1088/1755-1315/803/1/012039

24. Husna SS, Hintono A, Rizqiat H. Texture, water absorption, a_w and hedonic quality flakes white millet (*Panicum miliaceum*) with addition of pumpkin flour (*Cucurbita moschata*). Journal of Applied Food Technology. 2020;7(2):29–32.

25. Pongjanta J, Naulbunrang A, Kawngdang S, Manon T, Thepjaikat T. Utilization of pumpkin powder in bakery products. Songklanakarin Journal of Science and Technology. 2006;28:71–79.

26. Wijayanti I, Santoso J, Jacoeb AM. The effect of leaching times on the gel properties of catfish (*Clarias gariepinus*) surimi. Saintek Perikanan: Indonesian Journal of Fisheries Science and Technology. 2012;8(1):32–37. (In Indonesian).

27. Palawe J, Talete TK, Tatinting N, Tanod WA, Mandeno JA, Rieuwpassa FJ, *et al.* High calcium sago cookies fortification of tuna fish bone and seaweed *Caulerpa* sp. EnviroScienteae. 2021;17(3):106–115. (In Indonesian).

28. Varzakas T, Kiokias S. HPLC analysis and determination of carotenoid pigments in commercially available plant extracts. Current Research in Nutrition and Food Science. 2016;4(1):1–14. https://doi.org/10.12944/CRNFSJ.4.Special-Issue1.01

29. Rieuwpassa FJ, Karimela EJ, Cahyono E, Tomasoa AM, Ansar NMS, Tanod WA, *et al.* Extraction and characterization of fish protein concentrate from Tilapia (*Oreochromis niloticus*). Food Research. 2022;6(4):92–99.

30. Putri CYK, Pranata FS, Swasti YR. The quality of muffin with a combination of white kepok banana (*Musa paradisiaca* forma *typica*) and butternut pumpkin (*Cucurbita moschata*). Biota: Jurnal Ilmiah Ilmu-Ilmu Hayati. 2019;4(2):50–62. (In Indonesian). https://doi.org/10.24002/biota.v4i2.2471

31. Zuraida N, Supriati Y. Sweet potato farming as sources for food alternative and carbohydrate diversification. Buletin AgroBio. 2001;4(1):13–23. (In Indonesian).

32. Pudjihastuti I, Sumardiono S, Supriyo E, Kusmayanti H. Quality analog rice composite flour: Modified starch, colocasia esculenta, *Canna edulis Ker* high protein. AIP Conference Proceedings. 2018;1977.

33. Mamuja CF, Lamaega JChE. Production of analog rice from cassava, "Goroho" banana and sago. Jurnal Ilmu dan Teknologi Pangan. 2015;3(2):8–14. (In Indonesian).

34. Putra GH, Nurali EJN, Koapaha T, Lalujan LE. Manufacture of analog rice based on goroho banana flour (*Musa acuminate*) with *carboxymethyl cellulose* (CMC) binder. Cocos. 2013;2(4):1–12. (In Indonesian).

35. Cahyaningtyas FI, Basito, Anam C. The physicochemical and sensory assessment of pumpkin flour (*Curcubita moschata Durch*) as the substitution of wheat flour in the eggroll making. Jurnal Teknosains Pangan. 2014;3(2):13–19. (In Indonesian).

36. Ningtyas KR. Optimize formulation the breakfast meal flakes (food breakfast) bananas with the addition of pumpkins. Jurnal Pengolahan Pangan. 2018;3(2):32–27. (In Indonesian).

37. Ririsanti NN, Liviawaty E, Ihsan YN, Pratama RI. The addition of carrageenan to the preference level of catfish pempek. Jurnal Perikanan dan Kelautan. 2017;VIII(1):165–173. (In Indonesian).

38. Chakrabarti R, Gupta S. Characteristics of gel from the meat of twelve species of fish from Visakhapatnam Coast. Fishery Technology. 2000;37(1):5–7.

39. Maulid DY, Nurilmala M. DNA barcoding for authentication of mackerel (*Scomberomorus* sp) products. Jurnal Akuatika Indonesia. 2015;VI(2):154–160. (In Indonesian).

40. Pereira AM, Krumreich FD, Ramos AH, Krolow ACR, Santos RB, Gularte MA. Physicochemical characterization, carotenoid content and protein digestibility of pumpkin access flours for food application. Food Science and Technology. 2020;40(2):691–698. https://doi.org/10.1590/fst.38819

41. Simpson BK. Food biochemistry and food processing. Oxford: Wiley-Blackwell; 2012. 912 p. https://doi.org/10.1002/9781118308035

42. Kim MY, Kim EJ, Kim Y-N, Choi C, Lee B-H. Comparison of the chemical compositions and nutritive values of various pumpkin (*Cucurbitaceae*) species and parts. Nutrition Research and Practice. 2012;6(1):21–27. https://doi.org/10.4162/nrp.2012.6.1.21

43. Nilusha RAT, Jayasinghe JMJK, Perera ODAN, Perera PIP, Jayasingh CVL. Proximate composition, physicochemical, functional, and antioxidant properties of flours from selected *cassava (Manihot esculenta* Crantz) varieties. International Journal of Food Science. 2021;2021. https://doi.org/10.1155/2021/6064545

44. Dwijaya O, Lestari S, Hanggita S. Chemical characteristics and potential heavy metal contamination (Pb and Cd) of pempek in Palembang. FishtecH – Jurnal Teknologi Hasil Perikanan. 2015;4(1):57–66. (In Indonesian).

45. Bhat MA, Bhat A. Study on physico-chemical characteristics of pumpkin blended cake. Journal of Food Processing and Technology. 2013;4(9). https://doi.org/10.4172/2157-7110.1000262

46. Adebayo OR, Farombi AG, Oyekanmi AM. Proximate, mineral and anti-nutrient evaluation of pumpkin pulp (Cucurbita pepo). IOSR Journal of Applied Chemistry. 2013;4(5):25–28.

47. Chen L, Huang G. Antioxidant activities of phosphorylated pumpkin polysaccharide. International Journal of Biological Macromolecules. 2019;125:256–261. https://doi.org/10.1016/j.ijbiomac.2018.12.069

48. Dhiman AK, Sharma KD, Surekha A. Functional constituents, and processing of pumpkin: A review. Journal of Food Science and Technology. 2009;46(5):411–417.

49. Nururrahmah, Widiarnu W. Analysis of beta-carotene levels of dragon fruit peels using a UV-VIS spectrophotometer. Jurnal Dinamika. 2013;4(1):15–26. (In Indonesian).

50. Omeire GC. Amino acid profile of raw and extruded blends of African yam bean (*Sphenostylis stenocarpa*) and cassava flour. American Journal of Food and Nutrition. 2012;2(3):65–68. https://doi.org/10.5251/ajfn.2012.2.3.65.68

51. Duan Y, Li F, Li Y, Tang Y, Kong X, Feng Z, *et al.* The role of leucine and its metabolites in protein and energy metabolism. Amino Acids. 2015;48:41–51. https://doi.org/10.1007/s00726-015-2067-1

52. Pedroso JAB, Zampieri TT, Donato JrJ. Reviewing the effects of l-leucine supplementation in the regulation of food intake, energy balance, and glucose homeostasis. Nutrients. 2015;7(5):3914–3937. https://doi.org/10.3390/nu7053914

53. Layman DK. The role of leucine in weight loss diets and glucose homeostasis. The Journal of Nutrition. 2003;133(1):261S–267S. https://doi.org/10.1093/jn/133.1.261S

54. Duan Y, Li F, Liu H, Li Y, Liu Y, Kong X, *et al.* Nutritional and regulatory roles of leucine in muscle growth and fat reduction. Frontiers in Bioscience. 2015;20(4):796–813. https://doi.org/10.2741/4338

55. Pillai RR, Kurpad AV. Amino acid requirements in children and the elderly population. British Journal of Nutrition. 2012;108(S2):S44–S49. https://doi.org/10.1017/S0007114512002401

56. Jinap S, Hajeb P. Glutamate. Its applications in food and contribution to health. Appetite. 2010;55(1):1–10. https://doi.org/10.1016/j.appet.2010.05.002

57. Chen JQ, Li YS, Li ZJ, Lu HX, Zhu PQ, Li CM. Dietary L-arginine supplementation improves semen quality and libido of boars under high ambient temperature. Animal. 2018;12(8):1611–1620. https://doi.org/10.1017/S1751731117003147

58. Qiu Y, Yang X, Wang L, Gao K, Jiang Z. L-Arginine inhibited inflammatory response and oxidative stress induced by lipopolysaccharide via arginase-1 signaling in IPEC-J2 cells. International Journal of Molecular Sciences. 2019;20(7). https://doi.org/10.3390/ijms20071800

59. Szlas A, Kurek JM, Krejpcio Z. The potential of L-arginine in prevention and treatment of disturbed carbohydrate and lipid metabolism – A review. Nutrients. 2022;14(5). https://doi.org/10.3390/nu14050961

60. Cylwik D, Mogielnicki A, Buczko W. L-arginine and cardiovascular system. Pharmacological Reports. 2005;57(1):14–22.

61. Goli P, Yazdi M, Heidari-Beni M, Kelishadi R. Growth hormone response to L-arginine alone and combined with different doses of growth hormone-releasing hormone: A systematic review and meta-analysis. International Journal of Endocrinology. 2022;2022. https://doi.org/10.1155/2022/8739289

62. Gould A, Naidoo C, Candy GP. Arginine metabolism and wound healing. Wound Healing Southern Africa. 2008;1(1):48–50.

63. Sumarli, Rosmaiyadi, Triani SN, Kamaruddin, Buyung, Marhayani DA, *et al.* Toman fish nugget making training for the Kumba Village community in the Indonesia-Malaysia border region. International Journal of Public Devotion. 2021;4(2):69–74. (In Indonesian).

64. Restu. Making meatball of toman fish (*Channa micropeltes*). Journal of Tropical Animal Science. 2012;1(1):15–19. (In Indonesian).

65. Hermanto, Susanty A. Physicochemical and sensory characteristics of biscuit with toman fish (*Channa micropeltes*) flour addition. Jurnal Riset Teknologi Industri. 2020;14(2):253–262. (In Indonesian).

66. Yusuf AM, Saelan E, Lestari S. The effect of additional yellow pump with different persentages on organoleptic characteristics of chicken sausage. JANHUS Journal of Animal Husbandry Science. 2021;5(2):195–203. (In Indonesian).

67. Dewi AAEK. The effect of the pumpkin addition (*Cucurbita moschata*) on organoleptic quality, antioxidant capacity and nutrition value of wet noodles. Denpasar: Department of Nutrition, Politeknik Kesehatan, Ministry of Health; 2020. (In Indonesian).

68. Arisandi VS. Test of protein and organoleptic levels in yellow pumpkin (*Cucurbita moschata*) cake with the addition of natural dye). Surakarta: Muhammadiyah Surakarta University; 2012. (In Indonesian).