

The Effect of the Ratio of Chili to Sugar on Sensory and Physicochemical Analysis of Crushed Catfish Jerky

Anni Faridah ^{1)*}, Ranti Wahyuni¹, Riski Gusri Utami¹

¹Department of Family Welfare, Faculty of Tourism and Hospitality,
Universitas Negeri Padang, West Sumatera, Indonesia
Jl. Prof Dr Hamka Kampus UNP Air Tawar Kota Padang, 25131, Indonesia
Email: Faridah.anni@fpp.unp.ac.id

ABSTRACT

The standard recipe for crushed catfish jerky available presently tends to be sweet and lacks a diversity of seasonings. In preliminary research, panelists expressed their distaste for the standard recipe, notably because it contradicted the taste preferences of the Minangkabau people. The recipe was modified to obtain a richer product in herbs and spices to broaden the spectrum of consumers. The primary factors in this study were chili and sugar. Prior to this study, the ratio of chili to sugar in crushed catfish jerky had never been investigated. Therefore, this study aimed to analyze the effect of ratio chili to sugar (0:4, 1:0, 1:2, and 1:4) on the shape, aroma, texture, color, taste, and hedonic value of the product. Physicochemical analysis, including proximate analysis, color (L^ , a^* , b^*), and water activity, was continued on samples with the best treatment based on sensory test findings. This research was an experimental study with three repetitions of a Complete Randomized Design (CRD). Sensory data was acquired from a limited panelists who has completed the sensory test format. Following the data analysis with ANOVA, the Duncan test was performed. This study indicated that the ratio of chili to sugar in crushed catfish jerky has a significant effect on the sensory properties of texture, color, spicy taste, and hedonic level. However, it did not significantly affect the shape, aroma, and savory taste attributes. Compared to the control, adding chili powder and eliminating palm sugar could increase the protein, fat, ash, water content, water activity, redness (a^*), and yellowness (b^*) values of the product. On the other hand, the treatment reduced the product's carbohydrate value and brightness (L^*). This study suggested that the best chili to sugar ratio was 1:0 to obtain the best organoleptic profile and chemical properties of the product.*

Keywords: Catfish; Chili; Crushed Jerky; Sugar

INTRODUCTION

Jerky or *dendeng* is one of the authentic traditional beef-based cuisines from Minangkabau, West Sumatra. According to SNI or Indonesian national standard 2908-2013 on beef jerky, in its processing, beef jerky is made by sliced or milled, added with seasoning, then dried in the sun or dryer (BSN, 2013). Minangkabau jerky is characterized by a thin texture, indestructible, and spicy; in contrast, beef jerky on the island of Java is sweet and soft (Rosalina et al., 2015). The Minangkabau region is renowned for two types of jerky: *dendeng lambok* (moist jerky) and *dendeng kariang* (dry jerky) (Rini et al., 2020). West Sumatran dried jerky or *dendeng* shares the same properties as typical dried jerky from North America. Both products are classified as "shelf-stable food", which means they can be kept at room temperature in a sealed container for an extended period. The preservation and drying process is crucial for these commodities (Thiagarajan et al., 2006). Physically jerky is an Intermediate Moisture Food (IMF) product or a semi-wet food with low water activity characteristics that should not exceed 0.80 value to retain quality during storage, according to Konieczny et al. (2007).

The market price of beef jerky is relatively high, reflecting the high price of beef as the main ingredient for producing it. As a result, it is essential to substitute jerky's raw materials, which

are consumer-acceptable and accommodates animal protein's nutritional needs (Ikhsan et al. 2016). Catfish is high in protein (17.7 percent), fat (4.8 percent), minerals (1.2 percent), and water (75%) (Ubaidillah and Hersoelistyorini, 2010). The composition of catfish species is comparable to that of other fish species and beef meat (Casallas et al., 2012). Some catfish species contain higher protein than other protein sources, including beef (Ismanto et al., 2015). Catfish protein provides 95.03 g of essential amino acids per 100 g of protein, with lysine and leucine dominating (Oluwaniyi et al., 2017). Aside from being high in vital amino acids, this fish is also high in vitamins and minerals and has higher digestibility than beef. There is also a fatty acid fraction in catfish called oleic acid, which makes up as much as a third of the total lipids in catfish. Oleic acid has been shown to lower plasma cholesterol levels and cut the risk of heart disease by 20–40%. (Abdel-Mobdy et al., 2021). To diversify beef jerky, catfish has the potential to be one of the sources of animal protein used as a fundamental ingredient in jerky production. Furthermore, the utilization of catfish can address the increasing consumer demand for a diversity of food sensory attributes such as different textures and flavors (Konieczny et al., 2007).

Research on crushed catfish jerky has been conducted on the island of Java, where this catfish jerky tends to have a sweet flavor. Fitria (2018) developed a conventional recipe using palm sugar, coriander, salt, garlic, and seaweed. A preliminary study has been taken in our Laboratory to adapt Fitria's (2018) standard recipe, and a sensory analysis was carried out with several indigenous Minangkabau panelists. The panelists disapproved of the product based on early research findings, claiming that the crushed catfish jerky did not appeal to the Minangkabau people's tastes for spicy and herb-rich cuisine. To acquire a higher level of preference for the product, the recipe was adjusted by adding various spices, including ginger, galangal, tamarind, and shallots. However, the sweet flavor still dominates this modified recipe, despite knowing that the Minangkabau people prefer spicy flavors and despise sweet ones (Ariyani, 2013). As a result, we require the innovation of catfish jerky with an additional spicy flavor to increase the product's selling value and attract a wider range of consumers (including not only Javanese but also islanders who dislike sweet flavors).

Chili powder is a powdered version of chili pepper that is typically used to provide a spicy flavor to the cuisine. Chili pepper is a valuable product due to the attributes of color, taste, and pungency (Barbero et al., 2016). Capsaicinoids, a type of alkaloids, are mostly responsible for the pungency of chili peppers and their by-products (Orellana-Escobedo et al., 2012). The two major capsaicinoid compounds found in most *Capsicum* species, Capsaicin and Dihydrocapsaicin, comprise 80-90 percent of the capsaicinoids (Barbero et al., 2016). Capsaicin is the most prominent, accounting for 0.1 percent to 1% of the fruit's mass (Orellana-Escobedo et al., 2012). Capsaicin is the active compound in chili peppers that explains its health benefits. It contains antibacterial and antifungal qualities and is high in vitamin C, which has antioxidant properties (Omolo et al., 2018; Alvarez-Parrilla et al., 2011). Capsaicin is also an analgesic for arthritis pain and inflammation, anticancer, has anti-cholesterol and anti-obesity properties, and has a considerable impact on the cardiovascular and respiratory systems (Pelulola-Adeyemi et al., 2020). Furthermore, according to Dyastuti (2013), chili helps food products preserve quality by preventing rancidity, nutritional value changes, color and scent alterations, and other physical damage.

The inclusion of health-promoting spices such as chili powder in the production of crushed catfish jerky may be necessary to increase the product's added value. The quality of that product needs to be appropriately evaluated. The authors conducted an early study by adding 120 g of chili powder to crushed fish jerky, resulting in an unexpected fish jerky profile. Hence,

the authors arranged the amount of chili used to 30 g and reduced the amount of sugar used to prepare crushed catfish jerky. There have previously been no studies that focused on the chili-to-sugar ratio in processing catfish jerky. Consequently, this study aims to analyze the effect of the ratio of chili to sugar at a ratio of 0:4, 1:0, 1:2, and 1:4 on product quality by sensory and physicochemical analysis of crushed catfish jerky.

METHODS

This type of research was experimental research conducted in March - October 2021 at the Catering Workshop, Family Welfare Department, Faculty of Tourism and Hospitality, Padang State University, and the Agricultural Products Technology Laboratory, Faculty of Agricultural Technology, Andalas University.

Materials

The ingredients used to prepare crushed catfish jerky were fresh catfish, chili powder, palm sugar, coriander, galangal, salt, garlic, shallots, seaweed, tamarind, and ginger. Rawang Morning Market in Padang provided all of the ingredients. The materials used in the physicochemical examination were concentrated H₂SO₄ (95%), alcohol (95%), 0.1 N HCl, 40% NaOH, distilled water, petroleum ether, 3% boric acid, Kjeldahl tablets, 10% K₂SO₄, and phenolphthalein indicator (pp).

Tools

The tools utilized to make catfish jerky included analytical scales, cooking utensils, blenders, and food dehydrators. For physicochemical analysis, an analytical balance, Kjeldahl flask, burette, extraction flask, desiccator, electric burner, color search, rotronic cup, dew point meter, Minolta Chroma Meter CR-200, and Petri dishes were employed.

Research Design

The experimental design was a completely randomized design (CRD) with three replications and four levels of treatment. The treatment was the ratio of chilli to sugar in grams; X0 (0:4), X1 (1:0), X2 (1:2), and X3 (1:4), which can be seen in Table 1.

Crushed Catfish Jerky Production

The first step in producing mashed catfish jerky was to clean the catfish under running water to remove any contaminants, then separate the meat from the spines. Fish meat marinated in lime for 15 minutes, then rinsed and drained. The catfish meat was then mashed and pulverized until smooth.

The next step was to prepare the spices. This stage began with slicing palm sugar, roasting and mashing coriander, peeling and mashing garlic, shallots, ginger, and galangal. The seaweed was then soaked before being smashed with a blender. The tamarind was dissolved in boiling water, and then the soaking water was stored. The following ingredients were combined with catfish meat, chili powder, and salt to form a dough. The dough was molded to a thickness of 3mm and dried for 5 hours in a food dehydrator at 70 °C.

The mashed catfish jerky production process was completed by slicing the product into 5cmx5cmslices, then fried in a frying pan and ready for examination.

Table 1. Ingredients in each crushed catfish jerky treatments

Ingredients	Treatments			
	X0 (0:4) (Gram)	X1 (1:0) (Gram)	X2 (1:2) (Gram)	X3 (1:4) (Gram)
Chilli	0	30	30	30
Palm sugar	120	0	60	120
Catfish meat	610	610	610	610
Coriander	20	20	20	20
Galangal	20	20	20	20
Garlic	10	10	10	10
Shallot	50	50	50	50
Ginger	10	10	10	10
Seaweed	150	150	150	150
Salt	20	20	20	20
Tamarind	30	30	30	30

Data Analysis

Sensory data for mashed catfish jerky were obtained using the hedonic scale scoring method, one of the consumer acceptance test methodologies used to establish consumer's preferences for a product (Chambers, 1998). The parameters studied were the sensory value of color, texture, aroma, taste, and hedonic level, on a scale of 1-4. Sensory parameters were evaluated by five limited panelists, namely a culinary lecturer majoring in IKK (Family Welfare Science), Padang State University. Based on the results of this sensory test, the best treatment was continued to the following test, which was proximates analysis (protein, fat, water, carbohydrate, and ash contents), color test, and water activity to determine the physicochemical quality of catfish jerky products.

The contents of protein, ash, fat, water and carbohydrate were determined according to the standard method (AOAC, 2005). Semi-dried catfish jerky samples were chopped into small pieces and evenly dispersed throughout the Retronic Cup, then the product's samples' water activity was measured using a dew point water activity meter (AQUA LAB, 4TE). The calibration was performed with distilled water.

The color of the catfish jerky sample was obtained using a Minolta Chroma Meter CR-200 (Minolta Camera Co., Osaka, Japan) by pressing the tool firmly on the surface of the material being analyzed. The color parameters specified are the color reflectance L*(brightness), a*(redness), and b*(yellowness). Standardization of color measurement was carried out using a white calibration plate.

Analysis of variance (ANOVA) was used to analyze the sensory test data and continued with Duncan's multiple range test to differentiate the average value of the sensory test results. Software used was Microsoft Excel 2010 and SPSS version 22.

RESULTS AND DISCUSSION

Effect of the ratio of chili to sugar on the sensory quality of crushed catfish jerky

Shape

According to ANOVA, there was no significant difference between the different ratios of chili to sugar to the rate of square shape and product's neatness, as shown in Table 2. The square shape and neatness of the crushed catfish jerky were influenced by the printing process

using a baking sheet and cutting. Therefore, the ratio of chili to sugar did not affect the square and neat shape of the crushed catfish jerky.

Aroma

According to the ANOVA, the ratio of chilli to sugar has no significant effect on the sensory value of the aroma of crushed catfish jerky. Table 2 shows the average aroma assessment results for each treatment, ranging from 3.40 to 3.67, indicating that each treatment produced crushed catfish jerky with an identical aroma or a distinct beef jerky aroma. The indistinguishable aroma in all treatments might be generated from the same strong spices and herbs used in each treatment, such as coriander. Spices and seasonings enhance the aroma, color, and flavour of the food (Faridah, 2014). The components formed during the seasoning and drying processes provide a distinctive taste and smell (Hadiwiyo, 1994). In addition to the contribution of spices and herbs, the heating also imparts a particular aroma of catfish jerky. According to Harahap et al. (2021), the scent of catfish jerky emerges after the heating process when the substances of jerky partially evaporate and leave a distinct odour.

Table 2. The sensory value of samples crushed catfish jerky

Sample	Square Shapes	Neat Shapes	Aroma	Texture	Color	Savory Taste	Spicy Taste	Hedonic test
X0 (0:4)	3.87 ^a	3.67 ^a	3.67 ^a	2.73 ^a	2.73 ^b	2.93 ^a	1.20 ^a	2.95 ^a
X1 (1:0)	3.53 ^a	3.53 ^a	3.40 ^a	3.20 ^b	3.80 ^a	3.40 ^a	3.67 ^c	3.30 ^b
X2 (1:2)	3.73 ^a	3.60 ^a	3.47 ^a	3.00 ^a	3.67 ^b	3.27 ^a	2.93 ^b	3.00 ^a
X3 (1:4)	3.80 ^a	3.67 ^a	3.53 ^a	2.80 ^a	3.53 ^b	3.00 ^a	2.80 ^b	2.70 ^a

Note; The last letter of the same number in the column is not significantly different from $F_{count} < F_{table}$ at the 5% level and vice versa if the last letter of the number is not the same in the column, it is significantly different $F_{count} > F_{table}$ at the 5% level. X0(0:4) = no chili powder + 120 g palm sugar (control), X1(1:0) = 30 g chili powder + 0 g palm sugar, X2 (1:2) = 30 g chili powder + 60 g palm sugar, X3 (1:4) = 30 g chili powder + 120 g palm sugar.

Although ANOVA test did not reveal a significant difference, the X1 treatment (1:0) or the sample with the addition of chilli and no sugar had the lowest average value. On the other hand, treatment X0 (0:4), with 100 % sugar and no chiles, obtained the highest scent score. This could be related to the X1 treatment's spicy aroma, which is slightly pungent and unpleasant. The element of capsaicin contributes significantly to the pungent aroma of chilli in food (Ika et al. (2017). The higher the capsaicin level, the stronger the pungency fragrance released. Increased spicy scents due to increased capsaicin levels may affect consumer disapproval of the product (Peluala-Adeyemi et al., 2020). The fragrance of sugar, on the other hand, encouraged the panellists to assign the X0 treatment a slightly higher score. Dewi et al. (2006) claim that the aroma of fish jerky is influenced by the aroma of sugar, resulting in fish jerky with such a particular sweet aroma.

Texture

The texture is an attributes of sensory test through the sensation of touch or a pressure touch that can be detected by the mouth when biting, chewing, swallowing, or contacting with

fingers. According to the ANOVA data presented in Table 2, the ratio of chilli to sugar significantly affects the textural quality of crushed catfish jerky. Panellists' average texture assessment value ranged from 2.73 to 3.2. The X1 treatment (chilli to sugar ratio 1:0) with the highest texture average was categorized as having a "crunchy" texture. The crunchy texture may be influenced by the addition of chilli powder in the processing of jerky products. In line with Harahap et al. (2021), beef jerky processed with the addition of cayenne pepper and soaked in liquid smoke immersion has a crunchy texture. According to Ika et al. (2017), chilli pectin content is easily hydrolyzed into water-soluble components, thereby creating changes in food texture.

In contrast, crushed catfish jerky of treatment X0 (chilli-to-sugar ratio of 0:4) or without the addition of chilli has the lowest average textural value. It has a more rigid texture which panellists appreciate less. The concentration of sugar used in catfish crushed beef jerky may contribute to the significant difference in the texture of crushed catfish jerky. This conclusion is consistent with Ayu's (2021) studies, which showed that adding sugar increases the amount of bound water, making the pineapple pulp lunkhead rigid or rougher.

Color

Color is the consequence of the five senses of the eye, and it can be used to help people choose meals. Food colors that are pleasing to the eye are more likely to attract consumers. As a result, color is a critical factor in judging the quality of food goods (Ismanto et al., 2015). According to Mile et al., 2021, the hedonic criteria for a product's color affect consumer acceptance. The sensory color test was designed to measure the panellists' level of preference for the resulting jerky color.

The ratio of chillies to sugar has a considerable effect on the color of the catfish jerky produced (Table 2). The sensory color value of the product ranges between 2.73 and 3.80 on average. The color in the X1 (1:0) treatment was the color most preferred by the panellists. The color occurred was reddish-brown, almost identical to the reddish-brown color of dried beef jerky from the Minangkabau region.

The drying process causes a non-enzymatic reaction, also known as the Maillard reaction, the interaction between protein amino acids and reducing sugars that alters the jerky's color to brown (Lisdiana, 1977 in Ismanto et al., 2015). Interestingly, the treatment without any palm sugar still generates brownish jerky products. It could be because of tamarind utilization in crushed catfish jerky production. Indirectly, tamarind contributes its reducing sugar to the crushed catfish jerky. According to De Caluwe et al. (2010), tamarind has a sweet and sour taste related to the high content of tartaric acid and reducing sugars. In line with Wijayanti's statement (2016), the increase in reducing sugar content occurs due to heating and the addition of tamarind, which has a caramelizing effect and causes the color of the product to turn brown.

As the sugar content increased, the average color sensory value rated by the panellists declined, as demonstrated in the X2, X3, and X0 treatments (respectively 3.67, 3.53, 2.73). The more sugar used, the darker the jerky obtained due to the mixture of sugar and heat during frying (Febrianingsih et al., 2016).

The panellists probably disliked the intense dark brown color of the catfish jerky since they were accustomed to the reddish-brown hue of Minang Kabau beef jerky.

Taste (Savory and Spicy)

The nerve system of the tongue allows humans to taste sweet, sour, salty, or bitter flavours (Lobo, 2019). Taste is a sensation produced by taste receptors in the mouth and scent receptors in the nose that provides specific characteristics or sensations (Antara et al., 2012). Table 2 shows no significant difference in the savoury taste of crushed catfish jerky between the ratio of chilli to sugar treatments. It implies that the panellists perceive each treatment as having a savoury taste. The savoury flavour may be derived naturally from catfish as the primary ingredient, along with the spices and herbs used to produce crushed catfish jerky. In an analysis of the amino acid content of fish, Witono et al. (2017) reported that L-glutamic acid was recognized as the source of fish's natural savoury flavour. However, according to Table 2, treatment X1 (1:0), with the addition of chilli and without sugar, has the highest average savoury taste value of 3.40. In contrast, treatment control or X0 (0:4), without the addition of chilli, has the lowest average savoury value of 2.93.

Contradicted to the savoury taste evaluation, the ANOVA data in Table 2 demonstrates that the ratio of chillies to sugar significantly impacts the quality of spicy taste. The average value per treatment varied from 1.20 to 3.67. The product with chilli and no sugar (X1) had the spiciest flavour, while the control treatment with no chilli and 100 per cent sugar had the least spicy (X0). Chilli plants are high in vitamins A and C and the volatile chemical capsaicin, which can produce a spicy and hot flavour when used as a cooking spice (Harahap et al., 2021). A person's personal taste can strongly influence food's flavour. As a general rule, Minangkabau people enjoy foods with a spicy flavour (Ariyani, 2013). Therefore, it is possible that using the X1 treatment in the production of the catfish jerky may be adapted to adjust Minangkabau people's tastes in general.

Hedonic Test (Most favourite)

The hedonic test aimed to evaluate which chilli-to-sugar ratio the panellists preferred. Table 2 presents significant differences between treatments with varying chillies to sugar ratios on the panellists' favourite goods. Compared to the other treatments, the average hedonic value of the X1 product (1:0) is significantly higher at 3.30. According to the results, it can be inferred that Minangkabau people prefer the crushed catfish jerky with chilli but no sugar (X1), as compared to the sugar-only crushed catfish jerky (X0) or a chilli-sugar mixture (X2 and X3). It is consistent with Ariyani's (2013) argument that Minangkabau people prefer spicy foods in terms of appetite.

The proximate, color, and water activity results

Treatment X1 with a chilli-to-sugar ratio of 1:0 performed the optimal sensory value, particularly texture, color, spicy, and hedonic level. Furthermore, the X1 product was subjected to physicochemical examination. Physicochemical analysis involved proximates (protein, ash, fat, water content, and carbohydrate), color, and water activity levels. Physicochemical examination compares X1's physical and chemical quality to X0, the control. The X1 treatment was expected to have better physical and chemical qualities than the control and exceed beef jerky standard quality.

Proximate analysis results

The crushed catfish jerky in treatment X1 had more protein, fat, water, and ash than the control treatment, as shown in Table 3. In comparison to the X0, it climbed by 5.95 %, 2.14 %, 0.86 %, and 1.35 %, respectively.

The inclusion of chilli powder-derived components may increase the product's protein, fat, ash, and water content. Chilli includes 3.0% protein, 0.3% fat, and 83% water per 100 g, which might enhance the product's proximate composition (Pitojo, 2003). In a proximate analysis of beef burgers, Syaraf et al. (2015) discovered a substantial increase in protein and ash content after adding chilli. In a different study, Peluola-Adeyemi et al. (2020) reported adding 10% chilli powder to wheat flour elevated the bread samples' protein, ash, and fat content.

Table 3. The average of proximate composition (protein, fat, water content, ash level, and carbohydrate) of X0 and X1 treatments.

Parameter	Chili to sugar ratio w/w	
	X0 (0:4)	X1(1:0)
Protein %	17.2	23.15
Fat %	20.56	22.7
Water content %	7.81	8.67
Ash Level %	7.1	8.45
Carbohydrate %	47.33	37.03

Note; X0(0:4) = 0 chili powder + 120 g palm sugar (control), X1(1:0) = 30 g chili powder + 0 g palm sugar

According to the Indonesian beef jerky quality standard, BSN (2013), beef jerky must contain a minimum protein content of 18%. Thus, treatment X1's catfish crushed jerky meets the protein standard criteria (23.15%). This number is higher than the control, X0, which has a protein content of 17.2%. When combined with other high-protein meals, chili powder might be advised to meet specific dietary protein requirements. However, a national quality standard for catfish jerky has not yet been established. Therefore, the physicochemical quality of catfish jerky is compared to the Indonesian national standard quality of beef jerky, which is likewise a semi-wet product.

Fat is an essential nutrient for maintaining health. Fats' high energy content allows humans to store the most energy in the least amount of food. In addition, fats enable humans and animals to utilize fat-soluble vitamins and offer vital fatty acids, which their bodies are unable to produce (Bockisch, 2015). In comparison to the control treatment, the fat content of the X1 increased by 2.14 %. Chili may contribute to X1's greater fat content. Fresh red chilies contain 0.3% fat (Pitojo, 2003), and dry red chilies have around 6.20 g of total fat per 100 grams (Indonesian directorate of nutrition, 2005). However, the fat percentage of the X1 treatment is substantially higher than the maximum fat value required to meet the beef jerky quality standard of 3%. (BSN, 2013). It may develop due to the heating process during the frying of jerky at a particular temperature. Supporting Faridah et al. (2014), the increase in fat content is due to the addition of spices to the main ingredient and the use of cooking oil in the product frying process, where the meat has a cavity so it can absorb more oil (Ismento et al., 2015). The chemical composition of meat products processed by drying and frying will diminish the product's water content while increasing its fat content. Food items that have a high percentage of fat in them can readily become oxidized and give off a smell that is described as rancid, as stated by Lobo et al. (2019).

In jerky-type items, the chemical composition, particularly the water content, is critical for texture and shelf life (Konieczny et al., 2007). Water content can impair food quality, so it must be minimized during processing and storage (Abdullah et al., 2020).

The high water content of the product is directly related to the high water activity, which can stimulate the growth of microbiological activity (Emmanuel-Ikpepe et al. (2004). Measuring the water content is crucial for a product that needs to be preserved for long, such as jerky. Based on Table 3, the X1 treatment had an 8.67 % water content, 0.86 % greater than the control. In a study of Leubiem fish jerky, El Husna et al. (2014) discovered the best fish jerky comprised 8.20% moisture. Furthermore, according to Indonesian beef jerky standards, water content should not exceed 12%. (BSN, 2013). Because its water content was around 8.20-12%, the X1 treatment met acceptable quality beef jerky standards. The amount of sugar in a product might affect its water content following processing. The absence of sugar in the treatment resulted in higher water content for the X1 product. On the other hand, the higher the sugar contents, the more water will be bound, lowering the product's water content (Kartika and Nisa, 2015). In addition, the inclusion of chili to crushed catfish when preparing jerky will likely increase the amount of water present. The water content of dried chili is around 7-8 % (Setyawibawa, 2018), which may contribute to raising catfish jerky's water content.

The carbohydrate content of the X1 treatment was lower than the control, with values of 37.03 and 47.33, respectively, in contrast to the other proximate results (Table 3). The key component in decreasing the carbohydrate level of the X1 product was the elimination of palm sugar during catfish jerky production. Palm sugar is a disaccharide carbohydrate; hence reducing or removing it reduces a product's carbohydrate content. The inclusion of sugar in fish jerky and the length of the drying process, on the other hand, were found to contribute to the high carbohydrate content of beef jerky in a study (Maisyaroh et al., 2020). In addition to sugar, chili can impact the X1 treatment's low carbohydrate levels. Following Peleuola-adeyeye et al. (2020), the carbohydrate content of bread samples decreased significantly as the amount of chili powder increased. In addition, Adeyeye et al. (2020) reported that the low carbohydrate content of *Kilishi* or beef jerky may have contributed to the product's high crude protein content.

Color

Table 4 shows that the brightness level (L^*) of the X1 treatment (23.78) is lower than that of the control (29.35). The reduced use of palm sugar is associated with a decrease in the brightness value of the product. High sugar content in product processing, combined with prolonged product heating, results in the *Maillard* reaction, which gives rise to a dark brown and glossy product (Nugraha et al., 2021).

Table 4. The average of color value of X0 and X1 treatments

Parameters	Chili to Sugar ratio		
	X0(0:4)	X1(1:0)	X3 (1:4)
L*	29.35	23.78	26.3
a*	10.9	11.2	9.8
b*	8.7	9.2	6.5

Note; L stands for Lightness, a* for redness, b* for yellowness

In contrast, sample X1 with addition of chili powder and without added sugar displayed greater reddish (a*) and yellowish (b*) values compared to the control. It validates the conclusion of the earlier sensory research that the product's hue is reddish-brown, which panelists find more appealing than dark brown. According to Peluola-Adeyemi et al. (2020), the red color in chili-added samples comes from capsanthin, the major carotenoid in red chili.

Water Activity (Aw)

Water activity (Aw) is a number that indicates the intensity of water in non-aqueous elements. Water activity can be defined as the amount of available free water that microorganisms can utilize for biological activity. As a result, the Aw value is related to the food ingredient's durability (Nugraha et al., 2021). In Table 5, the water activity (Aw) value of the X1 treatment was higher than the control treatment, which was 0.64 and 0.59, respectively.

Table 5. The average of water activity of X0 and X1 treatments.

Parameter	Chili to Sugar ratio		
	X0(0:4)	X1(1:0)	X3(1:4)
Aw	0.59	0.64	0.61

Note; Aw for Water Activity. X0(0:4) = no chili powder + 120 g palm sugar (control), X1(1:0) = 30 g chili powder + 0 g palm sugar, and X3 (1:4) = 30 g chili powder + 120g palm sugar.

Eliminating palm sugar is responsible for the higher water activity value in catfish jerky products and vice versa; the addition of sugar reduces the jerky's water activity, as an example in Parrotfish jerky (Nugraha et al., 2021). According to Kartika and Nisa (2014), sugar has hygroscopic qualities, which allow it to bond water-free in food, lowering the material's water activity. The water activity of jerky can be reduced to 0.75 or less to increase storage stability (Allen et al., 2007). Jerky products can be classified as IMF (Intermediate Moisture Food) if the water activity does not exceed 0.80. (Konieczny et al., 2007). Based on the research above, the X1 treatment with the number 0.64 has met the water activity standard criteria for beef jerky. Therefore, it may be concluded that the product will be stable throughout storage, and it can be classified as IMF (Intermediate Moisture Food).

CONCLUSION

The ratio of chilies to sugar in crushed catfish jerky significantly affects the sensory properties of texture, color, spicy taste, and hedonic level of the product. In contrast, the

difference in the ratio did not significantly affect the shape, aroma, and savory taste properties. The addition of chili powder and the elimination of sugar in the treatment of chili to sugar ratio of 1:0 can increase protein, fat, ash, moisture content, water activity, redness value (a^*), and yellowness value (b^*) of catfish jerky products. On the other hand, it reduces the product's carbohydrate value and brightness (L^*). According to this research, the optimal ratio of chilies to sugar in the X1 treatment is 1:0 to achieve the required sensory profile and physicochemical properties of mashed catfish jerky.

ACKNOWLEDGEMENT

The authors would like to extend their gratitude to Lembaga Penelitian dan Pengabdian Masyarakat (LPPM) of Universitas Negeri Padang for the help on this research funding.

REFERENCES

- (AOAC) Association of Official Analytical Chemist. 2005. Official Methods of Analysis of the Association of Official Analytical Chemist. Arlington, Virginia (USA): Association of Official Analytical Chemist Inc. [BSN] Badan Standardisasi Indonesia. 2013. Beef Jerky. Dendeng sapi. SNI 01-2908: 2013. Jakarta
- Abdel-Mobdy, H.E., Abdel-aal, H.A., Souzan, S.L., & Nassar, A. (2021). Nutritional Value of African Catfish (*Clarias gariepinus*) Meat.
- Adeyeye, E. I., Adesina, A. J., Olaleye, A. A., Olagboye, S. A., & Olatunya, M. A. (2020). Proximate, vitamins, minerals compositions together with mineral ratios and mineral safety index of kilishi (Beef jerky meat). *Haya Saudi J. Life Sci*, 5(5), 79-89.
- Allen, K., Cornforth, D., Whittier, D., Vasavada, M., & Nummer, B. (2007). Evaluation of high humidity and wet marinade methods for pasteurization of jerky. *Journal of Food Science*, 72(7), C351-C355.
- Alvarez-Parrilla, E., de la Rosa, LA, Amarowicz, R., & Shahidi, F. (2011). Antioxidant activity of fresh and processed Jalapeno and Serrano peppers. *Journal of Agricultural and Food Chemistry*, 59 (1), 163-173.
- Antara, N. S., & Wartini, M. (2012). Aroma and flavor compounds. *Senyawa aroma dan citarasa*. Modul Kuliah. SEAFast-IPB, Bogor, 2012.
- Ariyani, NI (2013). The Minang People's Adaptation Strategy to the Language, Food, and Norms of the Javanese Society. *Community: International Journal of Indonesian Society and Culture*, 5 (1), 26–37. <https://doi.org/10.15294/komunitas.v5i1.2369>
- Ayu, D. F., Ali, A., & Steward, D. (2009). The manufacture of pineapple syrup (*Ananas comosus* L. Meer) with the addition of various concentrations of palm sugar. *Pembuatan Dodol Ampas Sirup Nenas dengan Penambahan Berbagai Konsentrasi Gula Aren. Jurnal Penelitian (Media Informasi Dan Komunikasi Ilmiah)*, 18(2).

- Barbero, GF, Liazid, A., Azaroual, L., Palma, M. & Barroso, CG (2016). Capsaicinoid contents in peppers and pepper-related spicy foods. *International Journal of Food Properties*, 19, 485- 493.
- Bockisch, Michael, ed. *Fats and oils handbook (Nahrungsfette und Öle)*. Elsevier, 2015.
- Cahyani, K. D. (2011). Study of red bean (*phaseolus vulgaris*) as a binder and filler in catfish sausage. *Kajian kacang merah (phaseolus vulgaris) sebagai bahan pengikat dan pengisi pada sosis ikan lele*. 2011.
- Chambers, E., 1998, *The 9 Point Hedonic Scale*, Peryam & Kroll Research Corporation. Chicago.
- Cruz Casallas, N. E., Cruz Casallas, P. E., & Suárez Mahecha, H. (2012). Characterization of the nutritional quality of the meat in some species of catfish: a review. *Revista Facultad Nacional de Agronomía Medellín*, 65(2), 6799-6809.
- De Caluwé, E., Halamouá, K., & Van Damme, P. (2010). *Tamarindus indica* L.—A review of traditional uses, phytochemistry and pharmacology. *Afrika focus*, 23(1), 53-83.
- Dewi, E.N, dan Ibrahim, R. 2006. Effect of Types of Sugar on Processing of Red Tilapia Jerky on Quality Pengaruh Jenis Gula pada Proses Pengolahan Dendeng Ikan Nila Merah Terhadap Mutu. *Jurnal Saintek Perikanan*. 2(1):22-29
- Directorate of Nutrition. 2005. DKBM (List of Food Ingredients Composition). DKBM (Daftar Komposisi Bahan Makanan). Jakarta: Indonesian Nutritionist Association (PERSAGI).
- Dyastuti, Endah Ayu; Nofiani, Risa; ardiningsih, Puji. Organoleptic test of grass jelly with the addition of garlic powder (*Allium sativum*) and chili powder (*Capsium annuum* L). Uji organoleptik cinalok dengan penambahan serbuk bawang putih (*Allium sativum*) dan serbuk cabai (*Capsium annuum* L). *Jurnal Kimia Khatulistiwa*, 2013, 2.2.
- El Husna, N., Asmawati, A., & Surwajana, G. (2014). Jerky Leubiem Fish (*Canthidermis maculatus*) with Variations in Making Methods, Types of Sugar, and Drying Methods. Dendeng Ikan Leubiem (*Canthidermis maculatus*) dengan Variasi Metode Pembuatan, Jenis Gula, dan Metode Pengeringan. *Jurnal Teknologi dan Industri Pertanian Indonesia*, 6(3).
- Faridah, A., & Holinesti, R. (2014). Tempe Nugget Organoleptic Test With Addition Of Carrots And Seaweed. Uji Organoleptik Nugget Tempe Dengan Penambahan Wortel dan Rumput Laut. (2014): 260-269.
- Febrianingsih, F., Hafid, H., & Indi, A. (2016). Kualitas organoleptik dendeng sapi yang diberi gula merah dengan level berbeda. *Jurnal Ilmu dan Teknologi Peternakan Tropis*, 3(2), 10-15.

- Fitria, A. (2018). Effect of Drying Temperature and Seaweed Substitution on the Characteristics of Minced Jerky Dumbo Catfish. Pengaruh Temperatur Pengeringan dan Substitusi Rumput Laut terhadap Karakteristik Cincang Dendeng Dumbo Lele.
- Hadiwiyoto, S. (1994). Study of Processing Jerky With Dryer Oven. Studi Pengolahan Dendeng Dengan Oven Pengering. *Buletin Peternakan*, 18(1994).
- Ika, S. dan S. Putri. 2017. Effect of Addition of Various Types of Chili (*Capsicum annum* L.) on Organoleptic Quality and Vitamin C Content of Wet Candied Siamese Pumpkin. Pengaruh Penambahan Berbagai Jenis Cabai (*Capsicum annum* L.) Terhadap Kualitas Organoleptik Dan Kandungan Vitamin C Manisan Basah Labu Siam (*Sechium edule*). *Jurnal Kebidanan*. 3(1): 43-49
- Ikhsan, M., Muhsin, M., & Patang, P. (2016). Effect of variations in drying temperature on the quality of African catfish jerky (*Clarias gariepinus*). Pengaruh variasi suhu pengering terhadap mutu dendeng ikan lele dumbo (*Clarias gariepinus*). *Jurnal Pendidikan Teknologi Pertanian*, 2, 114-122.
- Ismanto, S.D., Siswardjono, S., & Nengsih, S. (2015). Effect of the Addition of Catfish Meat on Improving of Jerked Meat Protein from Cassava Leaves (*Manihot utilissima*). *International Journal on Advanced Science, Engineering and Information Technology*, 5, 84-89.
- Kartika, P. N., & Nisa, F. C. (2014). Study of Manufacturing Odehydrate of Pineapple (*Ananas comosus* L. Merr): Study of sugar concentration in osmosis solution and Immertion Time.
- Konieczny, P., Stangierski, J., & Kijowski, J. (2007). Physical and chemical characteristics and acceptability of home style beef jerky. *Meat science*, 76 (2), 253-257.
- Lobo, R., Santoso, J., & Ibrahim, B. (2019). Characteristics of Mackerel Fish Meat Shredded With Addition Of Seaweed Flour *Eucheuma cottonii*. Karakteristik Dendeng Daging Lumat Ikan Tongkol Dengan Penambahan Tepung Rumput Laut *Eucheuma cottonii*. *Indonesian Journal of Fishery Products Processing*, 22 (2), 273–286.
- Maisyaroh U, Kurniawati N, Iskandar I, Pratama R. The Effect of Using Different Types of Sugar and Concentrations on the Preference Level of Tilapia Fish Jerky. Pengaruh Penggunaan Jenis Gula Dan Konsentrasi Yang Berbeda Terhadap Tingkat Kesukaan Dendeng Ikan Nila. *J Perikan dan Kelaut*. 2018;IX(2):138–46. (in Indonesia)
- Mariani Harahap, N. Ira Sari, S. (2021). Characteristics Of Milled Jerk Catin (*Pangasius Hypophthalmus*) Smoke With Variety Of Flavors. Karakteristik Dendeng Giling Ikan Patin (*Pangasius Hypophthalmus*) Asap Dengan Varian Rasa Terubuk *Fisheries Period*, 49 (2).

- Mile, L., Sulistijowati, R., Janrianto, W., & Rahman, D. (2021, October). Acceptability tilapia fish (*Oreochromis niloticus*) jerky: an application of the many-facets Rasch Model. In *IOP Conference Series: Earth and Environmental Science* (Vol. 890, No. 1, p. 012049). IOP Publishing.
- Nugraha, B. F., Sumardianto, S., Suharto, S., Swastawati, F., & Kurniasih, R. A. (2021). Analysis of the quality of tilapia jerky (*Oreochromis niloticus*) with the addition of various types and concentrations of sugar. Analisis kualitas dendeng ikan nila (*Oreochromis niloticus*) dengan penambahan berbagai jenis dan konsentrasi gula. (*Oreochromis niloticus*). *Jurnal Ilmu dan Teknologi Perikanan*, 3(2), 94-104.
- Oluwaniyi, O. O., Dosumu, O. O., & Awolola, G. V. (2017). Effect of cooking method on the proximate, amino acid and fatty acid compositions of *Clarias gariepinus* and *Oreochromis niloticus*. *Journal of the Turkish Chemical Society Section A: Chemistry*, 4(1), 115-132.
- Omolo, MA, Wong, ZZ, Borh, WG, Hedblom, GA, Dev, K., & Baumler, DJ (2018). Comparative analysis of capsaicin in twenty nine varieties of unexplored *Capsicum* and its antimicrobial activity against bacterial and fungal pathogens. *Journal of Medicinal Plants Research*, 12 (29), 544-556.
- Orellana-Escobedo, L., Garcia-Amezquita, LE, Olivas, GI, Ornelas-Paz, JJ, & Sepulveda, DR (2013). Capsaicinoids content and proximate composition of Mexican chili peppers (*Capsicum* spp.) Cultivated in the State of Chihuahua: Contenido de capsaicinoides y composición proximal de chiles mexicanos (*Capsicum* spp.) Cultivados en el estado de Chihuahua. *CyTA-Journal of Food*, 11 (2), 179-184.
- Pitojo. 2003. Benih Cabai. Kanisius, Yogyakarta
- Peluola-Adeyemi, O., Bolaji, OT, Adepoju, PA, Adeyeye, SAO, & Bello, IE (2020). Quality Significance and Assessment of Bread Spiced with Chili Pepper (*Capsicum annum*). *Journal of Food Stability*, 3, 81-91.
- Rini, -, Nanda, R.F., Syukri, D., & Derosya, V. (2020). The Effect of Cooking Method on the Nutritional Characteristics of “Dendeng Kariang” as a Traditional Minangkabau Food. *International Journal on Advanced Science, Engineering and Information Technology*, 10, 2126-2131.
- Rosalina, E., Ahmad, A. W., & Haryadi, A. D. (2015). Strategi Pengembangan Makanan Unggulan Minangkabau Berdaya Saing Global. *Akuntansi Dan Manajemen*, 10(2), 41-50.
- Sharaf, A. M., Abd-ElGhany, M. E., Abou-Zaid, F. O. F., & Zaghloul, A. (2015). Influence of the addition of chilli pepper (as phytochemical rich components) on the quality characteristics of beef burger patties. *Middle East Journal of Applied Sciences*, 5(4), 869-878.

- Thiagarajan, I. V., Meda, V., & Shand, P. (2006). Physico-chemical characteristics of beef jerky. In *2006 ASAE Annual Meeting* (p. 1). American Society of Agricultural and Biological Engineers.
- Ubaidillah, A., & Hersoelistyorini, W. (2010). Kadar Protein dan Sifat Organoleptik Nugget Rajungan dengan Substitusi Ikan Lele. *Jurnal Unimus*, 1(2), 1-12.
- Wijayanti, R. K., Putri, W. D. R., & Nugrahini, N. I. P. (2016). Pengaruh Proporsi Kunyit (*Curcuma longa* L.) dan Asam Jawa (*Tamarindus indica*) Terhadap Karakteristik Leather Kunyit Asam [In press januari 2016] *Jurnal pangan dan agroindustri*, 4(1).
- Witono, Y., Windrati, W. S., Taruna, I., Masahid, A. D., & Dardiri, A. B. (2017). The flavor enhancer profile resulting from the enzymatic hydrolysis of fish has low economic value in its use as an ingredient in food .Profil flavor enhancer hasil hidrolisis enzimatis ikan bernilai ekonomi rendah dalam penggunaannya sebagai ingredien pada makanan. *Jurnal agroteknologi*, 11(01), 69-81.
- Abdullah, N., Latief, R., Bastian, F., Sukendar, N. K., Djalal, M., & Pala'langan, M. R. (2020). The Effect of Kluwih (*Artocarpus communis*) Fruit Flesh Addition to the Nutrition Content of Mackerel Tuna Fish Abon. *Canrea Journal: Food Technology, Nutritions, and Culinary Journal*, 34-41.
- Setyawibawa, R., Ernes, A., & Sutrisno, E. (2018). Pengaruh Lama Pengeringan terhadap Kandungan Vitamin C pada Varietas Cabai Rawit Merah, Keriting, Dorset Naga dan Carolina Reaper. *Jurnal Ilmiah Teknologi Pertanian Agrotechno*, 3(1), 263-268.
- The Importance of Fats. (1998). *Fats and Oils Handbook*, 1–52. doi:10.1016/b978-0-9818936-0-0.50006-8.