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EFFECT OF DRYING TIMES AND TEMPERATURES ON THE QUALITY OF TRADITIONAL SPICY SAUCE CUBE

(Kesan Masa dan Suhu Pengeringan Terhadap Kualiti Kiub Sambal Tradisional)

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Abstract

Food drying is a food preservation method to inhibit bacterial, yeast and mold growth through the water removal technique. This study aims to analyze the effects of different drying temperatures and durations on the traditional spicy sauce cubes' qualities (moisture content, water activity, texture, color, disintegration time and sensory analysis). Different drying temperatures for the cubes consisted of three different stages temperatures were used to compare with the control cube's quality. The production of traditional spicy sauce cubes involved the preparation of fresh ingredients, cooked into a paste, drying, grinding the paste into powder and compacted into a cube molder (3.3×1.5 cm). It was found that the cubes with high initial temperature had lower moisture content than those with low initial temperature. The three-stage temperature cubes exhibited a lower water activity compared to other cubes and had higher hardness and lower fracturability but their color is still retained. All the traditional cubes had a disintegration time below 60 seconds which indicated the good quality of cubes. The different cyclic temperatures regime showed no significant difference to the aftertaste and overall acceptance among all prepared cubes. Overall, the significant differences in cubes' qualities were affected by varying the cyclic drying temperatures.

Keywords: traditional spicy sauce cube, cyclic drying temperatures, drying times

Abstrak

Pengeringan makanan adalah satu kaedah pegawetan makanan untuk mencegah pertumbuhan bakteria, ragi dan kulat melalui teknik penyingkiran air. Kajian ini bertujuan untuk menganalisis kesan suhu dan jangka masa pengeringan yang berbeza terhadap kualiti kiub sambal tradisional (kandungan kelembapan, aktiviti air, tekstur, warna, masa perlarutan dan penilaian sensori). Suhu pengeringan untuk kiub sambal tradisional yang terdiri daripada tiga tahap yang berbeza telah dibandingkan dengan kualiti kiub kawalan. Penghasilan kiub sambal tradisional merangkumi penyediaan bahan-bahan segar, dimasak menjadi pes, pengeringan dan pengisaran pes menjadi serbuk dan dipadatkan ke dalam acuan kiub (3.3×1.5 cm). Kiub sambal tradisional dengan suhu awal pengeringan yang tinggi didapati mempunyai kandungan kelembapan yang lebih rendah daripada suhu awal pengeringan yang rendah. Kiub dengan suhu tiga-tahap menunjukkan aktiviti air yang lebih rendah berbanding dengan kiub-kiub lain serta lebih keras dan tidak mudah pecah, tetapi warnanya masih dapat dikekalkan. Semua kiub sambal tradisional mempunyai masa perlarutan di bawah 60 saat yang membuktikan kualiti kiub yang baik. Kitaran suhu pengeringan yang berbeza menunjukkan tiada perbezaan yang signifikan terhadap kesan rasa dan penerimaan keseluruhan antara semua kiub sambal tradisional yang disediakan. Kesimpulannya, perbezaan ketara kualiti kiub sambal tradisional telah dipengaruhi oleh pelbagai kitaran suhu pengeringan.

Kata kunci: kiub sambal tradisional, kitaran suhu pengeringan, masa pengeringan

Introduction

Spicy sauce or known as *sambal* is an Indonesian chili sauce or paste usually made from a combination of a variety of secondary ingredients such as shrimp paste, garlic, ginger, shallot, scallion, palm sugar, and lime juice from a variety of chili peppers. In Malaysia, the spicy sauce had been known as one of the compulsory foods that were often served alongside the main meal such as *nasi lemak*, *nasi ayam*, and *asam pedas* [1]. The hot, sweet or a combination exhibited by chili or spicy sauce may differ from hot sauce in that many sweet or mild varieties exist, usually lacking in hot sauces. However, Malaysians also have their own interest in making the spicy sauce with spiciness or sweetness to be served in their meal. In contrast to hot sauces, the chili sauce can have a thicker texture and viscosity, while chili paste commonly refers to a paste where the chili pepper is the main ingredient. Some are used chili paste as a cooking ingredient, and some are used after preparation to season a sauce.

In this sophisticated era, the making of spicy sauce may be troublesome for certain individuals especially working spouses or individuals as its conventional cooking process is time-consuming which could affect their busy schedule. This is because the ingredients preparation and cooking process of chili paste requires expertise and reliability particularly, in flavor adjustment. In addition, this modern world had established bouillon cubes that growing consumers' demand in the market. These cubes have some beneficial factors such as convenient, easy-to-use, long shelf life without refrigeration storage, instantly add flavor and can balance almost any dish or soup for a short time. However, to the best of our knowledge, there is no standard method available in preparation of the cube that could mimic the original physical properties and sensory. Thus, this research is conducted to obtain the optimal physical and sensory characteristics of traditional spicy sauce cube.

For food products, it is important to ensure the drying rate is eligible as it can affect food quality. This is supported to a research conducted by Heldman and Hartel, that found the drying temperature, air velocity, relative humidity, pressure and features of food products (concentration and composition) are the key factors that may influence the drying process [2]. Moreover, based on the drying kinetics of tomato paste researched by Jumah et al., the increase in the temperature of the inlet air in the 60-100 °C range greatly increased the drying rate of tomato paste [3]. This indicates that the drying time would be decreased as the air temperature increased. For that reason, the drying time should be properly adjusted according to the air temperature to keep the good quality and nutritional composition of food products. Besides that, it has been reported that improving drying energy efficiency by only 1% could result in a profit increase of up to 10% [4]. The process of food dehydration corresponds to reduce the food moisture to low levels by adding one or more types of energy to the food can prolong the shelf life. This can be concluded that a good quality of product can be achieved with a reasonable drying period and lower consumption of energy. Hence, the factors of drying time and temperatures were highlighted in this study as they can be significant factors in the production of the best spicy sauce cube product.

In this study, the effect of drying times and temperatures in the process of making traditional spicy sauce cube were evaluated to provide the best solution in the product drying process which induced the optimal result of physical properties. The physical properties that were being conducted consist of moisture content, water activity, texture, color and disintegration time which these properties were related to the ability of cubes to withstand the environmental impact from the surroundings. Besides that, the sensory analysis will be conducted to evaluate the most consumer acceptance among the different samples. Based on the sensory analysis, the quality attributes entailing taste, aroma, appearance and texture are the most important aspects in the products to meet the requirements or demands of the consumer.

Materials and Methods

Materials

The fresh ingredients which consisted of dried chilies, onions, garlic and anchovies were purchased from L&L Mini Market, Pagoh Jaya, Johor while the commercial bouillon cube was bought from Green Apple Store, Pagoh, Johor. The preservative (sodium benzoate) was purchased from Tong Sheng Food Technology Sendirian Berhad, Pulau Pinang while the potato starch was bought from TF Value-Mart, Muar, Johor. All the ingredients used have been food grade acquired from local sources.

Production of traditional spicy sauce paste and cube

For the initial step, the preparation of fresh ingredients was started by cleaning dried chilies, fresh onion, garlic and anchovies to remove unwanted waste and excess dirt. The amount of the ingredients used is shown in Table 1. After that, the dried chilies were sliced to remove the seeds to ensure the smooth chili paste was produced as well as to reduce the spiciness of chilies. Next, the sliced chilies were soaked in hot water (100 ˚C) for 10 minutes. This process is to soften the chilies and facilitate the blending process. The dried chilies with the addition of 350 mL of water were blended thoroughly by using a kitchen blender (Toshiba, BL-60PHNMY, Japan) for about five (5) minutes at medium speed until forming a smooth chili paste. The minced onion, garlic and anchovies were blended by a kitchen blender. The cooking process of spicy sauce paste started with the addition of cooking oil into a frying pan and was heated at medium temperature (70-80 ˚C). Then, the chili pastes and the blended ingredients (onion, garlic and anchovies) were added to the same frying pan and stir-fried for 10 minutes. Next, the water was added to the mixture, slowly stirred and continues cooked for another 15 minutes. Lastly, the starch and sodium benzoate (preservative) were added to the paste. The amount of ingredients used has produced approximately 400 g of spicy sauce paste without the removal of oil.

Prior to drying, the paste was spread on the baking paper which formed a thin layer to deliver the efficiency of paste drying in the food dehydrator (Yisino, SX-770, Malaysia). Thus, the paste had been dried until the moisture content below 12% as it is significant to produce the cubes with low moisture content. The low moisture content of the cubes led to adequate textural properties as it induced higher hardness and lower fracturability [5]. Next, the dried paste was grounded into a smaller size using the dry blender (Panasonic, MX-SM1031, Japan) and molded into cubes form by using a 3.3×1.5×1.0 cm (long × width × thickness) molder.

Table 1. Ingredients used in the production of the traditional spicy sauce cube

Ingredients	**Amount**
Dried chilies	27 g
Fresh onion	260 g
Garlic	19 g
Anchovies	10 g
Starch	10 g
Sodium benzoate	0.1 g
Chilli paste	83 g
Cooking oil	15 mL

Drying times and temperatures variation profile

The minimum and maximum limit of the parameter in drying times and temperatures were according to some previous studies in the cubing process with modification [3, 6]. There are five (5) variations were made in drying temperatures which include the one-stage, two-stage and three-stage temperatures varied between 60 ˚C and 70 ˚C. One-stage temperature drying process consists of 60 ˚C for 12 hours which represented cube (a), two-stage temperature drying process consists of 60 ˚C (4 hours) + 70 ˚C (8 hours) represented as cube (b) and 70 ˚C (4 hours) + 60 ˚C (8 hours) represented as cube (c) while the three-stage temperature consists of 60 ˚C (4 hours) + 70 ˚C (5 hours) + 60 ˚C (3 hours) which represented cube (d) and 70 ˚C (4 hours) + 60 ˚C (5 hours) + 70 ˚C (3 hours) represented as cube (e). The approximate drying time was according to Wiriya et al. with modification to obtain the moisture content below 12% [6]. The spicy sauce paste was spread on a tray as a single layer and this drying process was carried out by using 150-200 g of paste for each variation. However, the traditional spicy sauce cube qualities were also being compared to commercial bouillon cube (brand *Tomyam Knorr*) to observe any differences in response analysis.

Determination of moisture content

The moisture content of cubes was determined by using a moisture analyzer (A & D, MX-50, USA). About five (5) grams of the sample was put on a dish and heated at 120 ˚C in the analyzer [7]. The experimental data was obtained with three (3) replications.

Analysis of water activity

The water activity of the spicy sauce cubes was analyzed by using a dew point equipment (Decagon Devices Inc, Aqualab 4TE, USA). This analysis was required approximately two (2) grams of the sample that was placed into a small cylindrical container with a diameter of 3 cm before the measurement at an ambient temperature of 25 ˚C [8].

Texture analysis

The texture of cubes in terms of fracturability and hardness were tested using a texture analyzer (TA. XT Plus, Stable Micro System, UK) which has been calibrated with 5000 g load cell before analyzing. Then, the texture analyzer mode was set respective to the cubes sample. The probe used was a 0.5’’ spherical probe and the platform was set to 10 mm from the probe [8].

Color measurements

Surface color measurement was conducted using the L*a*b* system (Universal HunterLab, Model 45/0 S/N CX-0413), calibrated to a standard black and white tile, prior to sample color measurement. L* corresponds to lightness, a* refers to red (+)/ green (-) and b* represents yellow (+)/ blue (-). The sample was weighed about five (5) grams, placed into the petri dish and covered. Three (3) measurements were conducted for each variation [8].

Analysis of disintegration time of cubes

The cubes were weighed at approximately five (5) grams and dissolved in hot water space. Then, stir the cubes manually to enhance the disintegration process. The time taken for the cubes to break down into smaller particles or granules was recorded by a timer/stopwatch [9].

Sensory analysis

Each variation of cubes (control cube, a, b, c, d and e) was dissolved in 10 mL of hot water and cooled for about five (5) minutes before being presented to the untrained panelist. The selection of panelists in Universiti Tun Hussein Onn Malaysia was random and should be complied to 50 respondents and above as according to Sharif et al. [10]. Therefore, a total of 50 untrained panelists have participated in this test to evaluate the acceptability of the cubes. For this sensory test, a 9-point hedonic scale was used ranging from ‘extremely dislike’ to ‘extremely like’. The score sheets were provided with the product and panelists were requested to rate the product according to the degree of their liking. Then, the average scores of the panelists were computed for different characters [11].

Statistical analysis of spicy sauce cube

One-way analysis of variance (ANOVA) was conducted to compare the means of two or more or more independent groups to determine whether there is statistical evidence that the associated population means are significantly different. One-way ANOVA, (IBM SPSS Statistics Version 26, USA) was used followed by Tukey honest significant difference (HSD) and least significant difference (LSD) multiple comparison test and *p* values ≤ 0.05, considered significantly different.

Results and Discussion

Spicy sauce cube prototype production

There are five (5) variations of different drying times and temperatures of the traditional spicy sauce cube and a commercial bouillon cube that acts as a control between groups of the physical properties' analysis. Figure 1 shows the traditional spicy sauce cubes and a commercial bouillon cube that have been obtained as a final desired product in this study. The production of cubes was initiated by the preparation of fresh ingredients, followed by, cooking the mixture of the ingredients into a paste and drying the paste according to the five (5) variations. After that, the dried paste was grounded into powder form prior to the cubing process by the molder. The drying temperature was in the range from 60 ºC to 70 ºC and the drying time was a total of 12 hours according to some previous research with modifications [3, 6]. This modification was made and accomplished to ensure the final product of spicy sauce cubes capable to achieve the desired moisture content which has to be beyond 12%. The dimensions (33 mm × 15 mm × 10 mm) and weight (10 g) as the homogeneity of traditional spicy sauce cubes attributed the good quality parameters.

In addition, the color of the cubes can be affected by the different drying times and temperatures due to browning reaction, therefore the lightness (L*), redness (a*) and yellowness (b*) of cubes have been studied to observe the homogeneity of the traditional spicy sauce cube production. However, the traditional spicy sauce cubes exerted almost the same brown-reddish color and had slightly different in lightness. Besides, the texture of the cubes also has been studied in terms of hardness and fracturability to observe which cubes had resulted in the higher hardness and lower fracturability. The higher hardness of cubes is more preferred in this study as it is related to the lower moisture content and provides a longer shelf life of cubes, while the lower fracturability also impeding the cubes to break easily [5]. Also, the fast-dissolving of the traditional spicy sauce cubes in hot water that was below 60 seconds is also more preferred as it is convenient to the consumers and showed the good quality of cubes.

Moisture content

The results of all tested physical properties of the cubes are shown in Table 2. It was found that the control cube (0.57%) recorded the lowest percentage in moisture than all traditional spicy sauce cubes prepared. The range of moisture content for all traditional spicy sauce cubes were in between 7.35-11.20%. This result was probably due to the higher water retention of the fresh ingredients used in traditional spicy sauce cubes and different cyclic drying temperatures [12]. The fresh ingredients tend to have higher amounts of water, thus, required more drying time or higher drying temperature. Cube (a) which implemented the one cyclic temperature indicated the highest moisture content due to dry out of all mixture at one time at a high temperature which leads to a hardened surface and hinders the evaporation of water inside from the center of the product to the surface [6]. However, the moisture content of traditional cubes in the present study obtained was in the range of ideal moisture content (below 12.00%) even though the result was quite higher than ideal moisture content from other studies [5].

Results also found that cube (c) and cube (e) had a lower moisture content than other traditional spicy sauce cubes, probably due to the higher initial stage temperature during the drying process. Then, the tempering time of the cubes was allowed with an acceptable high temperature during this period for the diffusion of moisture from the center to the cube surface. Therefore, during the second and third stages of drying without excessive heating, moisture removal of cubes can still be achieved, especially on the surface of the cubes. Based on the previous study by Chua et al., during the initial drying period, the effect of temperature tempering on the drying curves is important and is gradually less profound towards the later drying stage. This effect can be attributed to the rapid transfer of moisture and migration in the initial drying stage to the sample surface as a result of higher sensitive heat obtained due to higher air temperature [12]. Thus, the increase in the evaporation rate of moisture from the sample surface can contribute to the lower moisture content of the traditional spicy sauce cubes.

Water activity

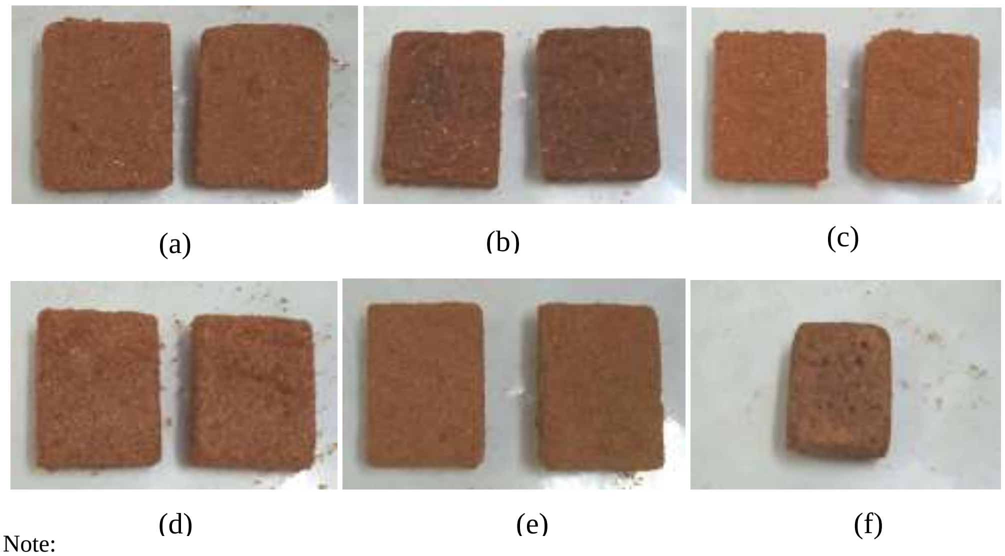
From Table 2, the results showed that overall cubes samples were in the range of 0.47-0.59 as the highest of water activity was the control cube (A_w = 0.59) and the lowest was cube (e) (A_w = 0.47). The water activity of the control cube was significantly different from other cube samples. The three cyclic drying temperatures which complied to both cubes (d) and (e) indicated no significant different ($p < 0.05$) between them but both had lower water activity when compared to the control cube and two cyclic drying temperature cubes which represented by cube (b) and cube (c). The lower water activity in a cube might be due to the tightly bound of water to a protein or carbohydrate molecule which corresponds to lowering and increasing drying temperature [13]. Based on previous research by Smorenburg and Yamson, the recommended water activity of a well-established bouillon cube is below 0.65 [14]. Nevertheless, the range of water activity of cubes can be within the range 0.413 to 0.505. A good flowability of powders in a bouillon cube can be indicated by low water activity [15]. In this study, the lower water activity is more preferably which is denoted by cube (d) and cube (e) to attribute the well-established with good flow-ability of powders of traditional spicy sauce cubes and attain the ambient stability as well as inhibit the survival of microorganisms.

Texture

The result of cubes' texture was shown in Table 2 regarding the hardness and fracturability obtained at 4.0 seconds. Cube (e) showed the highest hardness (0.632 kg) and fracturability (3.99 mm) among other traditional spicy sauce cubes. The good strength of cubes can be denoted due to higher hardness and lower fracturability, impeding the cubes to break easily [5]. According to prior research by Ansari et al., the moisture content was inversely proportional to the hardness of dried figs at a constant drying temperature [16]. On the other hand, the hardness of dried figs decreased with an increase in moisture content. This was possibly due to the lower resistance of the higher moisture content provided to crack the sample. Therefore, the lower rupturing force was required to rupture the dried figs. In overview, the highest hardness that was recorded by the cube (e) might be due to the lower water activity and moisture content as it required more force to break the cube. Thus, the formation of the cracks because the strength of cube (e) was the lowest which contributed to lower fracturability compared to the other cubes.

Color analysis

From Table 3, it presented that the lowest value of L* (lightness) was cube (b) (L*= 28.13) and the highest L* value was cube (d) (L*= 37.13). The two cyclic temperatures of cube (b) showed the darkest brown compared to others due to high temperatures with a long time as its temperature was elevated from 60 ^{o}C (4 hours) to 70 ^{o}C (8 hours). Those observations agreed with the results of Lee et al., who have suggested that a dark–brown color due to the non-enzymatic browning reaction was attributed to the use of high temperatures for drying air [17]. For three cyclic temperatures, both cubes of (d) and (e) showed more pure light than the one-stage temperature of cube (a) (L*= 31.77) but cube (e) exerted slightly darker than the control cube (L*= 34.64). The color of traditional spicy sauce cubes was influenced by many factors including the browning reaction of spicy sauce paste during cooking, the natural colors exhibited from the fresh ingredients and the Maillard reaction occurs in different cyclic drying temperatures. The fixed amount of the ingredients used in the cubes production were similar and according to the research methodology, however, the color of onion and garlic that contributed to brownish color may be differed due to the addition of water during paste preparation. According to Gupta et al., the enzymatic and non-enzymatic browning reactions are the main reactions that occur during drying [18]. On the other hand, the higher temperatures and intermediate levels of humidity in food contributed to the increases in the rate of non-enzymatic reactions [19].



Note:
(a) 60 °C (12 hours); (b) 60 (4 hours) +70 °C (8 hours); (c) 70 (4 hours) +60 °C (8 hours); (d) 60 (4 hours) +70 (5 hours) +60 °C (3 hours); (e) 70 (4 hours) +60 (5 hours) +70 °C (3 hours); (f) Commercial bouillon cube

Figure 1. Traditional spicy sauce cube and commercial bouillon cube

Table 2. Physical properties of traditional spicy sauce and control cubes

Cube Samples	**Physical Properties**			
	Moisture Content (%)	**Water Activity**	**Texture**	
			Hardness (kg)	**Fracturability (mm)**
Control	0.57±0.03^{a}	0.59±0.007^{c}	0.424±0.05^{b}	1.862±0.05^{cd}
(a)	11.20±1.03^{d}	0.52±0.01^{ab}	0.121±0.02^{e}	2.132±0.63^{bc}
(b)	8.46±0.47^{bc}	0.52±0.005^{ab}	0.223±0.02^{cd}	2.860±0.24^{b}
(c)	7.66±0.14^{bc}	0.55±0.05^{bc}	0.254±0.03^{c}	2.093±0.20^{bcd}
(d)	8.93±0.06^{c}	0.48±0.03^{a}	0.130±0.01^{de}	1.157±0.22^{d}
(e)	7.35±0.30^{b}	0.47±0.005^{a}	0.632±0.04^{a}	3.99±0.02^{a}

^{a,b,c,d} Values with different letters in the same row are significantly different ($p < 0.05$)
Note:
(a) 60 °C (12 hours); (b) 60 (4 hours) +70 °C (8 hours); (c) 70 (4 hours) +60 °C (8 hours); (d) 60 (4 hours) +70 (5 hours) +60 °C (3 hours); (e) 70 (4 hours) +60 (5 hours) +70 °C (3 hours); (f) Commercial bouillon cube

Table 3. Disintegration time and color analysis of the spicy sauce cubes

Cube Samples	Color			Disintegration Time (seconds)
	L*	a*	b*	Mean ± SD
Control	34.64 ± 0.88^{b}	16.08 ± 0.36^{c}	24.64 ± 0.58^{b}	247.00 ± 6.25^{d}
(a)	31.77 ± 1.12^{c}	19.99 ± 1.81^{b}	31.65 ± 4.21^{a}	42.09 ± 1.67^{c}
(b)	28.13 ± 0.62^{d}	19.30 ± 1.05^{b}	26.78 ± 4.54^{b}	30.30 ± 0.84^{c}
(c)	29.38 ± 0.09^{d}	21.77 ± 1.40^{a}	28.13 ± 3.82^{ab}	20.03 ± 0.42^{b}
(d)	37.13 ± 0.80^{a}	13.88 ± 0.50^{d}	19.66 ± 1.06^{c}	29.89 ± 0.30^{b}
(e)	33.18 ± 0.59^{c}	13.91 ± 0.41^{d}	14.78 ± 0.82^{d}	16.02 ± 0.09^{a}

^{a,b,c,d} Values with different letters in the same row are significantly different ($p < 0.05$)

Note:
(a) 60 ^{o}C (12 hours); (b) 60 (4 hours) +70 ^{o}C (8 hours); (c) 70 (4 hours) +60 ^{o}C (8 hours);
(d) 60 (4 hours) +70 (5 hours) +60 ^{o}C (3 hours); (e) 70 (4 hours) +60 (5 hours) +70 ^{o}C (3 hours)

Disintegration time

From Table 3, it indicates that all traditional spicy sauce cubes had disintegration time below 60 seconds, however, the control cube denoted the longest time to be disintegrated (247 seconds). All the traditional spicy sauce cubes dissolve rapidly in hot water due to the water heat that melts the fat which holds the cubes together. Nevertheless, it was observed that there was a separation of cubes powder and water that contributed to the sedimentation of powder at the bottom layer. The easily dissolving low-fat bouillon cube requires the provision of a free-flowing bouillon powder to a molder with a surface water residue [9]. A rapidly dissolving bouillon cube can be formed when the bouillon powder is compressed at low pressure. For cube (e), it showed the lowest disintegration time which is only 16.09 seconds compared to other cubes as well as denoted the best quality of fast-dissolving cube. Apart from that, the disintegration time of cubes can be related to the amount of moisture content as the higher moisture content possibly improved plastic deformation [20].

The higher moisture present decreased the compact force as it was capable of lowering the hydrodynamic resistance and thus increased elastic recuperation after dissolution [20]. In addition, the moisture content also corresponds to the disintegration time and porosity of cubes. As the increase in moisture content induced a substantial increase in porosity and a decrease in disintegration time, porosity was found to be consistent with disintegration time performance. Therefore, it was suggested that the high amount of moisture content probably contributed to the formation of a particle's freely moving environment, whereas the most acceptable compact configuration was attained. Meanwhile, the disintegration period was extended at low moisture content as the reduction of pores decreased the capacity of water to enter and break up the cubes [21]. In this study, the fast dissolution of the traditional spicy sauce cubes that below 60 seconds when compared to the control cube possibly attributed to the higher moisture content which contributed to the increasing of pores leads to improve the ability of water to enter and deform the cubes.

Sensory evaluation

Meanwhile, for the sensory analysis, the mean scores data of the hedonic test of cubes gravy by 50 panelists was presented in Table 4. Results from this study showed that the preference of cubes corresponding to the aftertaste and overall acceptance had the highest mean scores for the control cube compared to the traditional spicy sauce cubes, demonstrating the panelists preferred the control cube in the market. The mean scores of attributes aftertaste and overall acceptance of control cube were 6.18 and 7.24 respectively. However, the color for control cube was the least preferred by panelists due to the dark brown color compared to reddish-orange color of traditional spicy sauce cubes, which resulted from the mean scores of only 3.92. The reddish-orange color due to dried chili as the basic ingredients denoted the more pleasant color by panelists than dark brown color. Among the traditional spicy sauce cubes, cube (d) had the highest mean scores (6.58) of overall acceptances which showed a significant difference compared to others. Results obtained that cube (c) had the lowest mean scores for the taste properties which was only 3.72, indicated the most undesirable to the panelists.

Besides, the aftertaste of cube (a) (4.98), cube (b) (4.32), cube (d) (4.94) and cube (e) (4.44) were in the range of 4.32-4.98 which had significant different compared to cube (c) and control cube (6.18). Concerning the range of mean scores for the sensory assessment, the panelist did not notice remarkable differences in the final attributes of traditional spicy sauce cubes that were included of color, aroma, spiciness and aftertaste. The previous research has been shown that the decrease in drying air temperature from 70 °C to 50 °C resulted in less darkening of the tomatoes and an increase in the sugar or acid ratio, the impact of temperature can be linked to color and flavor changes [22]. Thus, the cyclic drying temperature for cubes provided a better condition of drying process additionally in consider of the sensory preferences in terms of color and aftertaste, the cube (e) which in compliance of three-stage temperature accompanied by the fastest dissolving (16.02 seconds) and low in moisture content (7.35%) was the most recommended for the production traditional spicy sauce cubes.

Table 4. Sensory evaluation of traditional spicy sauce cubes and control cube

Cube Samples	**Sensory Attributes**				
	Color	**Aroma**	**Spiciness**	**Aftertaste**	**Overall acceptance**
Control	3.92 ± 0.69^{c}	5.24 ± 0.77^{c}	4.7 ± 0.81^{bc}	6.18 ± 0.80^{a}	7.24 ± 0.65^{a}
(a)	5.58 ± 0.86^{b}	6.30 ± 0.65^{a}	4.96 ± 0.92^{b}	4.98 ± 0.62^{b}	5.46 ± 0.93^{c}
(b)	6.72 ± 0.99^{a}	5.16 ± 0.82^{c}	4.44 ± 0.64^{c}	4.32 ± 0.99^{c}	4.44 ± 1.09^{d}
(c)	5.88 ± 0.82^{b}	5.80 ± 0.78^{b}	5.94 ± 0.71^{a}	3.72 ± 1.07^{d}	5.64 ± 0.85^{c}
(d)	4.42 ± 1.03^{c}	5.18 ± 0.89^{c}	4.82 ± 1.10^{bc}	4.94 ± 1.02^{b}	6.58 ± 0.86^{b}
(e)	6.46 ± 0.86^{b}	6.34 ± 0.66^{a}	4.66 ± 0.79^{bc}	4.44 ± 1.11^{bc}	4.24 ± 0.71^{d}

^{a,b,c,d} Values with different letters in the same row are significantly different ($p < 0.05$)

Note:

(a) 60 °C (12 hours); (b) 60 (4 hours) +70 °C (8 hours); (c) 70 (4 hours) +60 °C (8 hours);

(d) 60 (4 hours) +70 (5 hours) +60 °C (3 hours); (e) 70 (4 hours) +60 (5 hours) +70 °C (3 hours)

Conclusion

The experimental results showed that the two-stage and three-stage cyclic drying temperatures exhibited a lower moisture content than one-stage temperature of traditional spicy sauce cubes. The cubes of three-stage drying temperatures had a lower water activity than the one-stage and two-stage temperatures might be due to the more efficiency of water removal during the drying process. Moreover, the hardness and fracturability of three-stage temperature that complied to cube (e) exhibited the best result compared to other traditional spicy sauce cubes as it had the highest hardness and the lowest fracturability. Moreover, the color of the cubes characterized in three-stage temperature was being improved in terms of lightness, redness in two-stage temperature and yellowness in one-stage temperature. Apart from that, the disintegration times of all traditional spicy sauce cubes are below 60 seconds which denoted the fast-dissolving and good quality of cubes. The one-stage drying temperature attained the most preferably aroma and taste among the traditional spicy sauce cubes probably due to the lower drying temperature which decreased the aroma volatile compounds to be evaporated. In conclusion, it is suggested that the temperature applied to have to be lowered to 70 °C and increase the drying time to achieve qualities and consumer acceptability of traditional spicy sauce cubes that could be comparable to the commercial bouillon cube.

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