Properties of ready to eat ground beef jerky with the addition of tapioca flour

Cite as: AIP Conference Proceedings **2586**, 060008 (2023); https://doi.org/10.1063/5.0111168
Published Online: 24 January 2023

B. R. Handayani, W. Werdiningsih, T. I. Rahayu, et al.

Properties of Ready to Eat Ground Beef Jerky with the Addition of Tapioca Flour

B R Handayani[1, a)], W Werdiningsih[1], T I Rahayu[1], A Z Fajri[2]

[1]*Faculty of Food Technology and Agoindustry, Mataram University, 83115, Mataram, Indonesia*
[2]*PT Mayora Indah. Tbk. Kalideres, Daerah Khusus Ibukota Jakarta 11840, Jakarta, Indonesia*

[a)] Corresponding author: baiqrienhs@unram.ac.id

Abstract. The processing of ready–to–eat beef jerky generally produce a number of meat flakes that are not utilized and will be detrimental to the beef jerky processing business group. Adding fillers such as tapioca flour will be profitable for jerky producers. This study aims to determine the effect of filler concentration on characteristics of ready–to–eat ground beef jerky produced. The research method used was an experimental method with a completely randomized design (CRD) with one factor, namely the concentration tapioca flour as filler consisted of 0, 5, 10, 15 and 20%. The parameters observed were chemical, physical, microbial, and sensory properties. Data were analyzed with analysis of variance (ANOVA) at 5% significance level using Co–Stat Software. Different data of chemical, physical and microbial were further tested with HSD test, while sensory was tested with DMRT at 5 % significance level. The results showed that addition tapioca flour had significantly different effect on the properties of ground beef jerky ready to eat mainly on water and protein content, color, flavor, taste, texture, L value and total microbes. However, it had no different on Hue value and total mold. It is recommended to use 10 % of tapioca flour to produce good quality of Ready–to–eat ground beef jerky with 24.38%water content, 22.51% of protein content, sensory value with favorable criteria. While total microbe and fungi has met the quality requirements of the contamination limit set by Indonesian national Standard.

INTRODUCTION

Beef jerky is one form of processed beef that is generally produced by the community/Micro Scale Medium Enterprises (MSMEs) ina simple way [1], namely by making slices or grinding fresh beef from healthy cows that have been seasoned and dried. The part of beef that is best used for beef jerky is the scrub section, butthe price of the scrub is relatively more expensive than the price of the other parts [2]. The method of processing beef jerky by slicing or slicing beef is more widely used by beef jerky producers than processing by grinding, although the slicing method results in a lot of small flakesfrom the scrub were being wasted. So that the small flakes from the scrub are not wasted, the alternative is to switch to using beef jerky that is crushed (grinded) so that all parts of the meat can be used as beef jerky. Ground beef jerky is ground meat, added with spices (coriander, garlic,galangal, tamarind, sugar, and salt), printed in the form of thin sheets and then dried. Ground beef jerky can also be made by mixing ground beef with spices and flour. According to [3] that a mixture of 60 g tapioca flour with 300 g of rejected rabbit meat resulted in good quality ground beef jerky and acceptable to the panelists. [4] also used 10% tapioca flour as a filler for fish and 5% for rabbits.

Several advantages are obtained by processing ground beef jerky, namely in addition to using wasted meat flakes, it can also produce traditional beef jerky which is more varied than sliced/sliced beef jerky [5]. Research on the processing of ready–to–eat traditional beef jerky has been carried out but does not use crushing/grinding techniques. Therefore, research on "The Effect of Filler Concentration on Several Quality Components of Ready–to–Eat Beef Jerky" needs to be done.

The Third International Symposium on Food and Agrobiodiversity (ISFA 2021)
AIP Conf. Proc. 2586, 060008-1–060008-10; https://doi.org/10.1063/5.0111168
Published by AIP Publishing. 978-0-7354-4231-3/$30.00

MATERIALS AND METHODS

Materials

Equipment used included: meat slicer (SIRMAN, Italy), electric oven (MEMMERT, Germany), gas stove (COSMOS), colorimeter (MSEZ User Manual). Materials used were beef flakes (which has no fat), coriander, garlic, brown sugar, cinnamon, cloves, saparwantu, anise, cummin, pepper, salt, galangal, liquid smoke gade I "LIQUID SMOKE" (Coco Power, PT. Tropica Nucifera Industri, Bantul–Yogyakarta).

Methods

Processing of ground beef jerky was carried out by modifying the process of making traditional beef jerky found in Lombok, especially in the Seganteng area, Cakranegara [6, 7]. The research method used was the Experimental Method with a Completely Randomized Design (CRD) with one factor, that is the concentration of filler (tapioca flour) which consists of five treatments, namely: 0%, 5%, 10%, 15% and 20% of tapioca flour. Each treatment in was repeated three times to obtain 15 experimental units. Parameters observed were chemical, physical, organoleptic and microbiological quality. Chemical quality that was observed includes, water content (thermogavimetry) and protein content (Kjeldhal method) [8], physical property was color, organoleptic properties were hedonic color, flavor, texture and taste and microbiological properties were total microbial and total mold. Microbiological properties were determined by using plate count method [9]. Data from chemical, organoleptic and microbiological observations were analyzed by analysis of variance (ANOVA) at a 5% significance level using Co–Stat software. Significantly different data (chemical, physical and microbiological data) were further tested with the Honest Significant Difference Test (HSD). Duncan's Distance Significant Difference Test (DMRT) was carried out for organoleptic parameters at the same significant level [10].

RESULTS AND DISCUSSION

Effect of Filler Concentration

Moisture Content

The concentration treatment of tapioca filler had a significantly different effect on the water content of ground beef jerky as shown in Fig. 1 below:

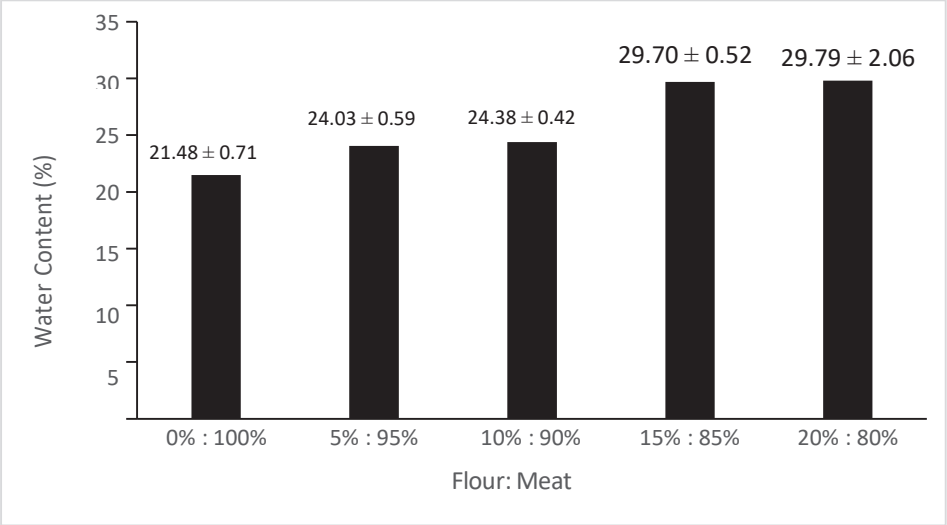

FIGURE 1. The effect of filler concentration on water content of ready–to–eat ground beef jerky

The treatment of 0% tapioca filler concentration was significantly different with the addition treatment of 5%, 10%, 15% and 20%. But the addition of 5% tapioca was not significantly different from 10% as well as the addition of 15% was not significantly different from the addition of 20% filler. It can be seen that the average water content increased, namely: 21.48%, 24.03%, 24.38%, 29.7% and 29.8%. Processing of ground beef jerky without the addition of filler (0% treatment) showed the lowest water content. This is because during the steaming process there is lysis of most of the water bound in the meat tissue into the container and is wasted in the next process. The increase in starch flour as a filler was directly proportional to the increase in the water content of ground beef jerky. This is presumably due to gelatinization of the starch contained in flour as filler [11]. Tapioca contains high starch so that in the process of mixing spices and steaming water absorption occurs by tapioca starch during the starch gelatinization process. The results of the study by Sayuti*, et al.* also showed that the moisture content of the moringa analogue jerky increased with the increase in the amount of tapioca flour added as filler [12]. Not only that, the addition of tapioca flour in the manufacture of cassava leaf jerky also showed an increase in the water content of cassava leaf jerky [13]. As disclosed by [14] that gelatinization is a gel formation phenomenon that begins with swelling of starch granules due to water absorption. When raw starch is placed in cold water, the starch granules will absorb water and start to swell but are limited to about 30% of the weight of the flour. The process of heating the flour dough will cause the granules to swell even more due to the absorption of more water. The temperature at which swelling is maximal is called the gelatinization temperature. Furthermore, the development of starch granules is also caused by the entry of water into the granules and trapped in the composition of the molecules that make up the starch. The mechanism of development is because amylose and amylopectin molecules are physically only maintained by the presence of weak hydrogen atom bonds from other hydroxyl groups. When the temperature of the suspension and the kinetic energy of the water molecules increase, the hydrogen bonds between water molecules become weaker [15]. The water content of ground beef jerky with the addition of tapioca up to 10% still meets the water content standard of beef jerky required by the Directorate of Nutrition, Ministry of Health of the Republic of Indonesia (1981) of a maximum of 25%. However, the 15% and 20% treatments did not meet the water content standards because they had total water content above 25%, namely 29.70% and 29.80%, respectively.

Protein Levels

The treatment of giving filler material gave a significantly different effect on the protein content of ground beef jerky can be seen in Fig. 2 below:

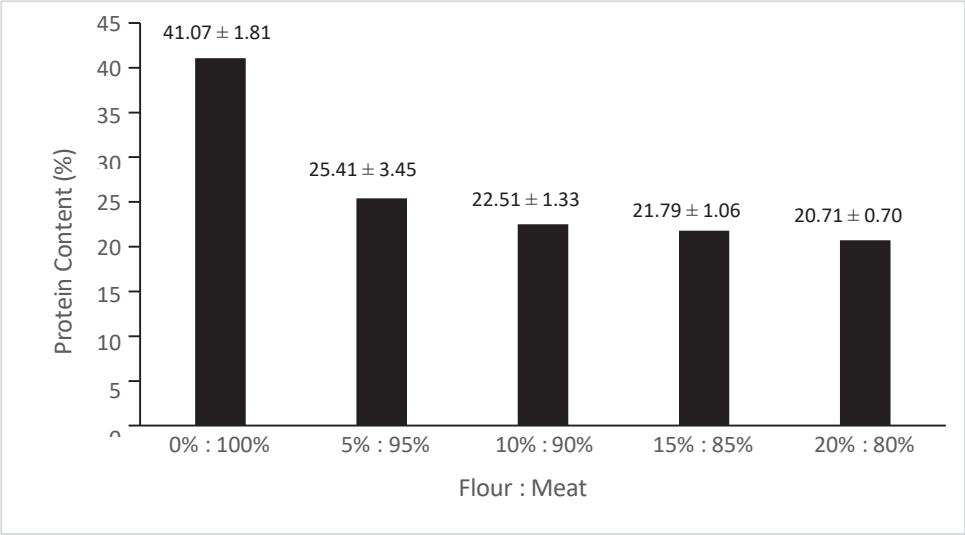

FIGURE 2. The effect of filler concentration on protein content of ready–to–eat ground beef jerky

The treatment with the addition of 0% filler was significantly different from all treatments but the addition of 5% filler was not significantly different from the 10%, 15% and 20% treatment. It can be seen that the average

protein content decreased successively with the increasing number of fillers added, i.e.: 41.07%, 25.41%, 22.51%, 21.79% and 20.71%. This is in line with [16] who reported that the use of tapioca flour increased the protein content of white shrimp jerky. The decrease in protein content is thought to be due to the reduced percentage of meat with increasing use of tapioca. In addition, tapioca also causes the water content in the material to increase. Tapioca flour contains very high starch so that in the process of mixing spices and steaming there is gelatinization of starch, which is the process of binding water by starch, causing the water content in the material to increase. The results showed that the addition of filler has an effect on increasing the water content of jerky. This causes all dissolved components including protein to decrease. This is in accordance with the statement of [14] and [17] which states that if the water content of the material increases, the dissolved compounds in the material decrease. Protein content that meets the quality requirements of quality II beef jerky in Indonesia which has been determined with the SNI number 01–2908–1992, which is 25%, is only obtained in the treatment of adding fillers as much as 5%, which is 25.41% while other treatments are less than 25% [18].

Color Value

The addition of filler has an effect on the color of beef jerky and can be seen in Figure 3. Figure3 shows that the addition of 0% was significantly different from the addition of fillers of 5%, 10%, 15% and 20%. However, the addition of 10% filler was not significantly different from theaddition of 15% and 20% filler. The average value of preference for colors in a row are: 3.75; 3.2; 2.25; 2.1 and 2.3 with criteria like to dislike. The higher the preference values for color, the lower the panelists' acceptance of the jerky color. The color of jerky without the addition of filler (0%) has the highest color preference value with the criteria of dislike, while the lowest value of preference is obtained with the addition of filler as much as 15% with the criteria of liking.

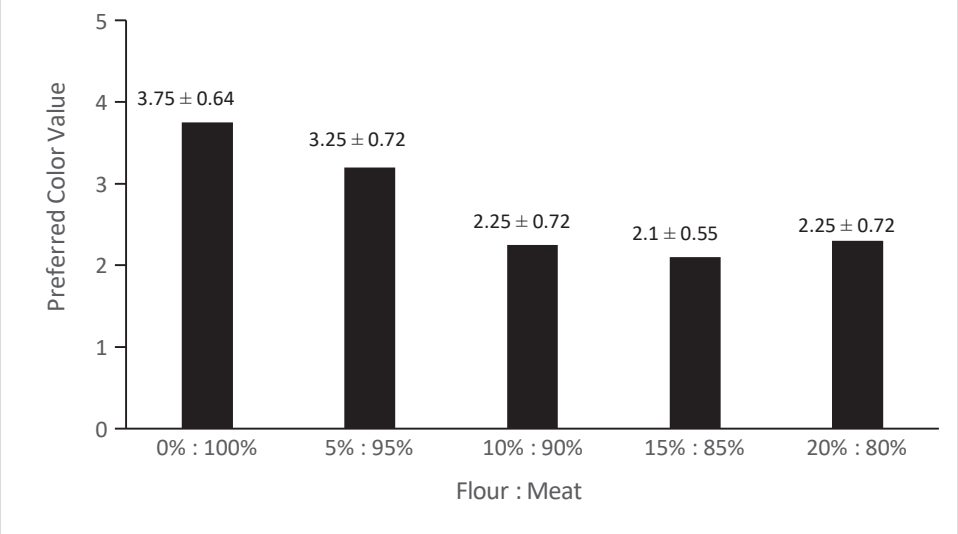

FIGURE 3. The effect of filler concentration on the color value of ready–to–eat ground beef jerky

This value indicates that the panelists' acceptance of the color of ground beef jerky is better with the addition of filler. With the addition of 15% filler, the color of the beef jerky changed to brown, and the panelists liked it because the color was like beef jerky in general. While in the treatment without the addition of fillers (0%) the color of the jerky looked pale and faded so that the panelists did not like it. Panelists tend to prefer the color of beef jerky containing tapioca flour as filler, the higher the concentration of filler, the higher the preference value for color. The color change in beef jerky is thought to be caused by the addition of seasoning or seasoning with the addition of liquid smoke and tapioca flour and heating which causes the beef jerky to turn brown in color. During heating there is a color change due to the presence of sugar in the spices which results in a Maillard reaction and caramelization. Maillard and caramelization reactions occur when ground beef jerky has been added to an oven at a temperature of 135°C. According to [14] and [17] the Maillard reaction produces melanoidin pigment which is responsible for the

formation of brown color and the caramelization reaction produces brown color through chemical reactions that occur in simple sugars due to the heating process.

Panelists are more likely to like ground beef jerky with a reddish-brown color. Figure 3 also shows that the more tapioca flour is added, the panelists' acceptance of color preferences increases as indicated by a decrease in the organoleptic color scale.

Flavor

The addition of filler has an effect on the flavor of beef jerky which can be seen in Figure 4 below.

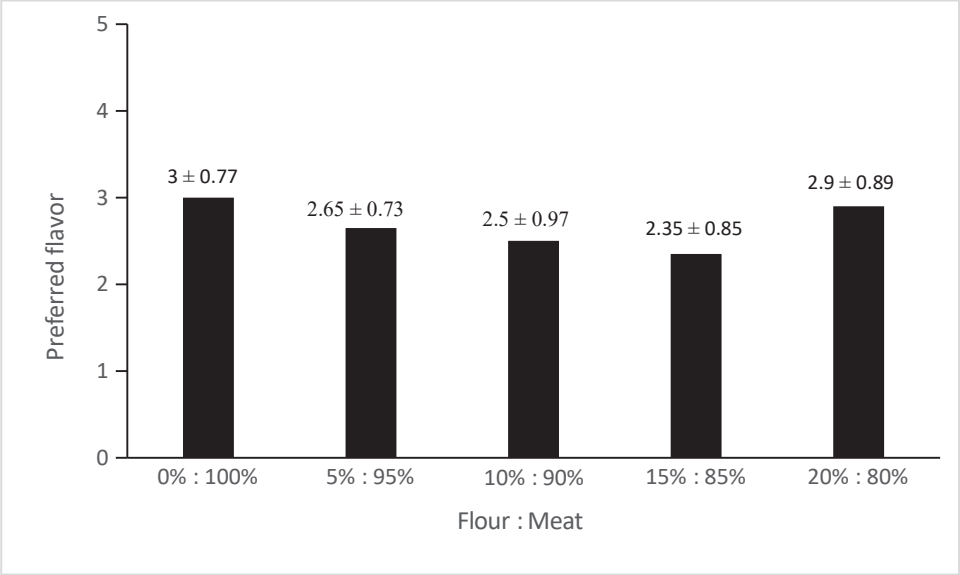

Figure 4. The effect of filler concentration on the flavor of ready–to–eat ground beef jerky

Figure 4 shows that the addition of 0% tapioca flour filler was significantly different from the 15% addition treatment, but the 15% addition of filler was not significantly different from the5%, 10% and 20% treatment. The average value of flavor preference in a row are: 3; 2.65; 2.5; 2.35 and 2.9. The highest preference value was obtained in the treatment without the addition of tapioca flour filler (0%) with neutral criteria and the lowest value in the treatment of adding fillers as much as 15% with preferred criteria. Panelists liked the addition of tapioca flour as much as 15% because the flavor of spices was more dominant, but the flavor of flour and liquid smoke did not appear. The ground beef jerky with the addition of tapioca flour as a filler has a flavor that is not too strong and pungent so that the panelists can still accept the flavor of ground beef jerky produced. The flavor of tapioca flour is not too dominant, evenly distributed with ground beef jerky which has a distinctive beef jerky flavor. In the research of [19] it was found that the flavor of stingay milled beef jerky preferred by the panelists was stingay ground beef with 10% tapioca addition treatment and a drying temperature of 70°C. The flavor of stingay milled beef jerky is formed by the presence of volatile compounds. Volatile compounds in food have an influence on the characteristics of the flavor and flavor produced. This statement also reinforces the results of research by [16] which also showed a change in the amino acid component in white shrimp jerky with the addition of tapioca flour. This will affect the final flavor produced by jerky.

Preferred Value.

The addition of filler has a significant effect on the preference value for the texture of groundbeef jerky. It can be seen in Figure 5 below:

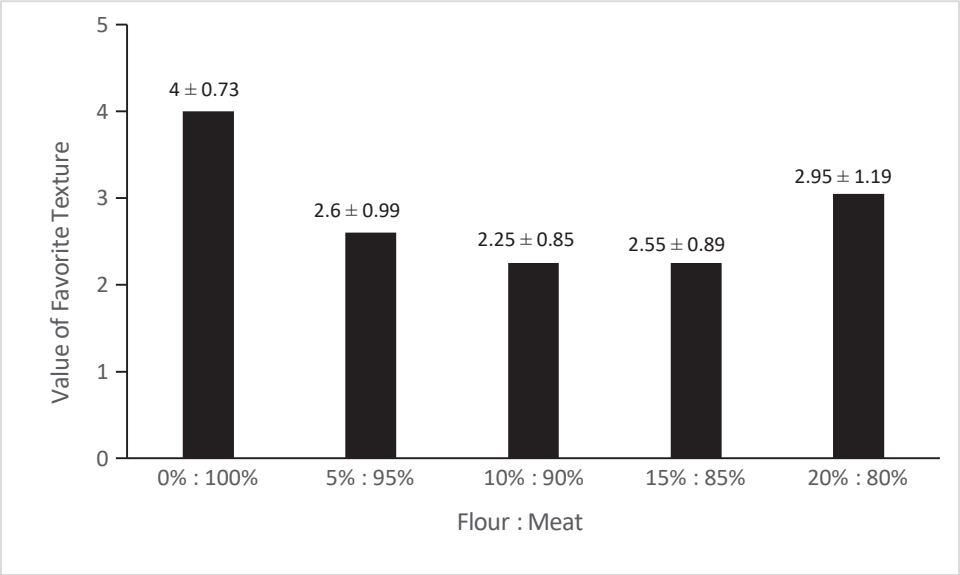

FIGURE 5. Graph of the effect of filler concentration on the value oftexture of ready–to–eat ground beef jerky

Based on Figure 5 above, the treatment of adding 0% filler was significantly different from all treatments. The addition of 20% filler was not significantly different from the 5% and 15% treatments. While the addition of fillers as much as 15% was significantly different from the treatment of 0% and 20%. The average texture preference values are 4, 2.6, 2.25, 2.55 and 3.05 with the criteria of liking to dislike. The texture of jerky in the treatment of adding fillers as much as 0% has the highest texture value score with the panelists' dislike criteria. This is presumably because the jerky produced without the addition of filler has a crumbled texture/jerky in the form of crumbs. Meanwhile, the lowest preference value was obtained from the addition of 10% filler with preferred criteria because 10% tapioca flour was added to the texture of ground beef jerky, compact, soft and easy to bite/not hard. The panelists' acceptance of the ready–to–eat ground beef jerky texture in the treatment of adding fillers of 5%, 15% and 20% was in the criteria of moderately preferred with a not tough texture.

The expected texture for this ready–to–eat ground beef jerky is beef jerky with a soft and not tough texture. [17] stated that dehydrated products will produce tougher and more fibrous meat. However, the oven process with a temperature of 135^0C will result in changes in the texture of the meat. According to [17], cooking meat with an internal temperature of 65–67^0C causes the fibers to shrink when collagen is denatured, resulting in hardening of the meat. To get tender meat, it is necessary to increase the internal temperature of the meat with longer cooking. Thus, the beef jerky texture that is close to the criteria is in the addition of 10% filler. As in [4] which used rabbit meat as an ingredient to make ground beef jerky, panelists were more likely to like ground beef jerky with the addition of 10% filler because the resulting beef jerky texture was soft and not tough. Similar results were also shown in white shrimp jerky. The addition of tapioca flour correlated to the water holding capacity of beef jerky. This causes the texture of beef jerky with the addition of tapioca flour to be better than the control beef jerky without the addition of tapioca [16].

Taste Value.

The addition of fillers in all treatments had a significant effect on the value of beef jerky taste preferences. It can be seen in Fig. 6 below:

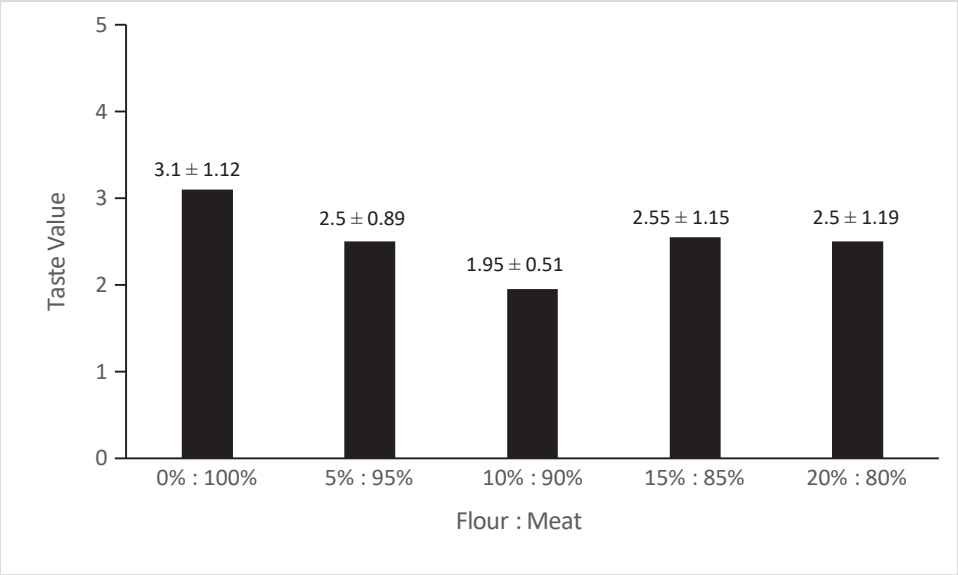

FIGURE 6. Graph of the effect of filler concentration ontaste value of ready–to–eat ground beef jerky

The addition of 0% filler was significantly different from the addition of 10%, but not significantly different from the 5%, 15% and 20% treatments. Meanwhile, the addition of 5% filler was not significantly different from the 10%, 15% and 20% treatments. The average value for taste preferences were 3.1; 2.5; 1.95; 2.55 and 2.5 with criteria like to dislike. The smaller the preference value, the higher the panelist acceptance rate. The panelists' acceptance of the highest taste for beef jerky with the addition of 0% filler was 3.1 with the criterion of being somewhat favored (neutral). Although the addition of fillers as much as 5%, 10%, 15% and 20% were not significantly different, the lowest preferred value was obtained in the treatment of adding 10% fillers with preferred criteria. According to research by [20], panelists prefer ground beef jerky with a strong spice taste and not too much flour content. This is reinforced with research by [4] which states that in all treatments the addition of filler (tapioca flour) by 5–20% in ground beef jerky produces beef jerky with a flour taste that is not too dominant and can still be accepted by panelists but has a tendency to be slightly different. It is preferred when the concentration of tapioca flour increases. The analogous type of beef jerky from cassava leaves also shows the same thing. This is because the addition of tapioca flour filler can bind oil during the frying process which will affect the savory taste produced by jerky [12].

Color (Colorimeter)

Based on Table 1, it can be seen that the addition of filler has a significantly different effect on the L value (brightness) of ground beef jerky. Based on the calculation of the $^{\circ}$Hue value from the value and the b value, the resulting jerky has a Red Purple color range (reddish purple). The relationship of adding filler material to ready–to–eat ground beef jerky using a colorimeter(MSEZ User Manual) based on the L value (brightness) can be seen in Table 1 below:

TABLE 1. Effect of filler concentration on the color of ready–to–eat ground beef jerky

Filler Concentration (%)	Value			
	L	a	b	°Hue
0	25,80 d	2,87	5,00	60,14
5	27,68 b	4,11	7,84	58,52
10	33,12 a	6,59	15,57	66,75
15	24,60 e	3,17	5,43	59,72
20	27,56 c	5,22	10,83	64,27

Note: The numbers followed by the same letters in the same column show no significant difference at the 5% significance level.

The L value is the value given to the brightness of a product by showing numbers rangingfrom 0 to 100. A value of 0 is black and a value of 100 is white, so the higher the range of L values obtained, the brighter the color of the product. The treatment with the addition of 0% filler was significantly different from all treatments with the addition of filler. The average brightness values are 25.8, respectively; 27.68; 33.12; 24.6; 27.56. The highest L (brightness) value was found in the addition of 10% filler, which was 33.12, while the lowest was found in the 15% addition of filler, which was 24.6. The highest brightness value in the addition of 10% filler was caused because the flour mixture was not too much or just right. If too much filler is added, the beef jerky will darken because it undergoes a non–enzymatic browning reaction. This is in line with the results of research by [4] which states that the addition of fillers in meat will result in non–enzymatic browning reactions during the oven process. The non–enzymatic browning of theresulting jerky was caused by the Maillard reaction. According to [14] the Maillard reaction is a reaction between carbohydrates, especially reducing sugars with primary amine groups. In beef jerky, the Maillard reaction occurs due to the reaction between the reducing sugars from tapioca and the protein in the meat. The sugar in the meat is obtained from brown sugar in the spices so that in the heating process at a temperature of 135°C browning occurs. However, sometimes browning can be a sign of a decline in quality. These results indicate that the more tapioca flour is added, the non–enzymatic browning will occur which causes the color of the meat to darken [14].

Total Microbial (TPC)

The number of microbes that contaminate ground beef jerky products is listed in table 2 below. Table 2 showed that the addition of fillers has an effect on reducing the number of microbes in ready–to–eat ground beef jerky with the addition of fillers as much as 0%, 5%, 10%, 15% and 20%, respectively.

TABLE 2. Effect of filler concentration on microbial growth in ready–to–eat ground beef jerky

Concentrationof Fillers (%)	Microbial Growth (CFU/g)	
	Total Microbe	Total Fungi
0	< 8,1 x 104	< 1.0 x 101
5	< 7,5 x 104	< 1.0 x 101
10	< 1,0 x 103	< 1.0 x 101
15	< 1,0 x 103	< 1.0 x 101
20	< 1,0 x 103	< 1.0 x 101

The total number of microbes in ready–to–eat ground beef jerky were: < 8.1 x 10^3CFU/g, < 7.5 x 10^3 CFU/g, < 1.0 x 10^3 CFU/g, < 1.0 x 10^3 CFU/g and < 1.0 x 10^3CFU/g. With the addition of tapioca flour as filler, the total microbes in the 10%, 15% and 20% treatments decreased drastically compared to the treatment without fillers. Allegedly this isbecause flour is able to bind liquid smoke which is antimicrobial. The addition of tapioca flour as a filler resulted in reduced free water in the meat because it was bound by starch in the gelatinization reaction [21]. This is reinforced by research by [20] on ground beef jerky that the presence of flour in the ingredients results in a

more optimum process of spreading liquid smoke throughout the ingredients. Because the process of entering liquid smoke into the meat takes a long time, in the presence of tapioca flour which produces a gelatinization reaction, the liquid smoke will be bound and remain on the ingredients. The total number of microbes in beef jerkyin the 10%, 15% and 20% treatments met the requirements for the maximum limit of microbial contamination in beef jerky which was determined by the SNI number 7388:2009, namely 1 x 10^5 CFU/g [18]. This is because high temperatures can kill microbial vegetative cells as a whole. In addition, the addition of liquid smoke to spices contains phenolic compounds, carbonyls and acids that can act as anti–microbial [22].

The Number of Mold.

Table 2 also shows that the number of molds contained in ready–to–eat ground beef jerky in all treatments was very low, namely <1.0X10^1 CFU/g or not detected. The addition of filler did not affect the decrease in the total number of molds in ready–to–eat ground beef jerky. Ready–to–eat ground beef jerky, all treatments had met the quality standards for quality I beef jerky in Indonesia which had been determined with SNI number 01–2908–1992, which was no visible mold on beef jerky. The small number of molds found in beef jerky in all treatments could be due to the hygienic process of making beef jerky. The spices and herbs used have gone througha roasting process, thus minimizing contamination of molds from bamboo. Mold also cannot grow because ground beef jerky is made through the oven process. In the oven process, the meatis baked at a temperature of 135°C so as to reduce mold contamination in the ingredients. In addition, the oven process at high temperatures kills mold gowth. This is because most molds belong to the mesophilic group and are sensitive to high temperatures [23].

CONCLUSION

The addition of fillers (tapioca flour) as much as 0%, 5%, 10%, 15% and 20% gave significantly different effects on water content, protein content, color, flavor, taste, texture, L value and total microbial but not significantly different on hue and total mold values. Ready–to–eat ground beef jerky with the addition of fillers as much as 0%, 5% and 10% meets the requirements for water content of beef jerky according to the Directorate of Nutrition, Ministry of Health, Republic of Indonesia in 1981. Ready–to–eat ground beef jerky with the addition of 5% filler material meets the requirements for beef jerky protein content according to the Directorate of Nutrition, Ministry of Health, RI in 1981 as much as 25%. 4. Ready–to–eat ground beef jerky with the addition of 10%, 15% and 20% fillers meet the quality requirements for the total microbial contamination limit stipulated in SNI 7388:2009. Ready–to–eat ground beef jerky with the best quality was obtained using 10% tapioca flour as a filler which was characterized by a water content of 24, 38%, protein content of 22.51%, organoleptic (color, flavor, taste, and texture) with the criteria are preferred, while the total microbial and total mold contamination has met the quality requirements of the contamination limit set by SNI. It is hoped that further research can use fillers other than tapioca flour.

REFERENCES

1. Handayani B R, Widyastuti S, Kertanegara, Hidayati A, Werdiningsih W, and Rahayu T I, “The use of a very small business–scale oven to enhance quality of "ready–to–eat" beef jerky,” in 3rd International Conference On Bioscience and Biotechnology, IOP Conference Series: Earth and Environmental Science 712, (IOP Publishing, 2021), pp. 1–6.
2. Purnomo H 1996 Dasar–dasar Pengolahan dan Pengawetan Daging. PT Gasindo. Jakarta.
3. Kartini 2009 Pembuatan Dendeng Sapi. Penerbit Sinar Baru. Bandung.
4. Nursiam 2010 Pembuatan Dendeng Giling. http://intannursiam.wordpress.com
5. Widati, Sawitri dan Thohari 1997 Pembuatan Dendeng Giling. http://intannursiam.wordpress.com
6. Rahayu T I 2012 Pengaruh Penggunaan Asap Cair terhadap Beberapa Komponen Mutu Dendeng Sapi Yang Diproses Secara Tradisional. Skripsi Fakultas Teknologi Pangan dan Agoindustri–Universitas Mataram. Mataram.
7. Handayani B R, Kertanegara ,Margana C C E dan Hidayati A 2012 Laporan Penelitian Masterplan Percepatan dan Perluasan Pembangunan Ekonomi Indonesia (MP3EI) 2012– 2015, Koridor V ke Peternakan dan Perikanan : Diversifikasi Dendeng Sapi “Jerky” Tradisional Siap Saji Menggunakan Asap

Cair Sebagai Pengawet Alamai Untuk Meningkatkan Keamanan Pangan dan Perekonomian Masyarakat NTB. Universitas Mataram. Mataram.
8. Sudarmaji SB, Haryono B dan Suhardi, 2007 Prosedur Analisa untuk Bahan Makanan dan Pertanian. Liberty, Yogyakarta.
9. W. F. Harrigan, Laboratory Methods in Food Microbiology 3rd Edition (Academic Press, San Diego, 1998).
10. Hanafiah K A 2002 Rancangan Percobaan Teori dan Aplikasi. PT. Raja Gafindo Permata. Jakarta.
11. S. K. Ku, J. D. Park, N. H. Lee, H. J. Kim and Y. B. Kim, Physicochemical and sensory properties of restructured jerky with four additives, Korean J. Food Sci. An. 33, 572–580 (2013)
12. Sayuti, R. Yenrina, and Y. Febri, 2020 "Characteristic of analogue jerky made from moringa leaves (Moringa oleivera L) with the addition of tapioca flour," in International Conference of Sustainability Agriculture and Biosystem, IOP Conference Series: Earth and Environmental Science 515, (IOP Publishing, 2020), pp. 1–10
13. Firdausni, Anova I T 2015 Pemanfaatan Daun Ubi Kayu Menjadi Dendeng Sebagai Makanan Alternatif Vegetarian Pengganti Protein. Jurnal Litbang Industri Vol. 5 No. 1, Juni 2015: (61–69)
14. Winarno F G 1992 Kimia Pangan dan Gizi. Gedia. Jakarta
15. Soeparno 1994 Ilmu dan Teknologi Daging. UGM–Press. Yogyakarta.
16. S. Ridhowati, S. Lestari, S. D. Lestari, and D. I. Sari, Physicochemical and sensory properties from indonesian white shrimp (Penaeus merguiensis) jerky, Pertanika J. Trop. Agic. Sci. 42, 833 – 845 (2019).
17. Lawrie R A 2003 Ilmu Daging. Terjemahan A. Prakkasi. UGM Press. Yogyakarta
18. Badan Standarisasi Nasional 2008 Mutu Karkas Dan Daging Sapi. http://sisni.bsn.go.id/index.php?/sni_main/sni/detail_sni/7783.
19. Garnida Y, Turmala E S, Iskandar J 2015 Pengaruh Penambahan Tepung Tapioka dan Suhu Pengeringan Terhadap Karakteristik Dendeng Giling Ikan Pari. http://www.teknik.unpas.ac.id
20. Rahayu 2009 Pembuatan Dendeng Giling. Teknologi Pangan dan Gizi. Institut Pertanian Bogor. Bogor.
21. Ferawati 2010 Pengaruh Proses Pengolahan Terhadap Sifat Fisik Dendeng Giling. http://lheofadley.blogspot.com/2013/01/dendeng-giling_8.html.
22. Darmadji P 2009 Teknologi Asap Cair dan Aplikasinya pada Pangan dan Hasil Pertanian. Pidato Pengukuhan Jabatan Guru Besar dalam Bidang Pangan dan Hasil Pertanian pada Fakultas Teknologi Pertanian Universitas Gadjah Mada. Yogyakarta
23. Hidayat N, Padaga M C dan Suhartini S 2008 Mikrobiologi Industri. Andi. Malang