The study of addition variety of vegetable flour on physical characteristics of tortilla chips

The study of addition variety of vegetable flour on physical characteristics of tortilla chips

A N Syarifah[1] and D Amrih[2]
[1,2] Department of Agricultural Product Technology, Faculty of Agriculture
Universitas PGRI Yogyakarta
Jl. PGRI I No.117, Sonosewu, 55182, Yogyakarta, Indonesia
atikansyarifah@upy.ac.id

Abstract. Tortilla chips are a snack product made from corn which have a bright yellow color with a crispy texture. Variations in the manufacturing process are needed so that the resulting tortillas have more attractive colors and better textures. The purpose of this study was to determine effect substitution of cornflour with various variations vegetable flour on the appearance in the color and texture tortillas. This study uses a completely randomized design (CRD) with two factors. The factor is type of vegetable flour red spinach, beets, spinach, and celery flour and the concentration of vegetable flour substitution 10%, 25%, and 50%. The analysis used was color and texture analysis. The results showed the highest L value of the color test was in the control tortilla of 46.74. The A value of red spinach tortilla and beets have higher value than control, green spinach, and celery.. The B value of control has the highest value followed by green spinach and celery tortillas. The tortilla chips texture test can be seen from the amount of the Fbreak. The lowest Fbreak value found in red beet tortillas is 1.83, which shows that beetroot tortilla has the most crispy texture compared to other variation tortillas.

1. Introduction

Indonesia is an agricultural country that has the potential of various and abundant natural resources. The number of rice fields in Indonesia until 2014 was 7.6 million hectares which have the potential to be planted with various types of food crops such as rice, corn, cassava, and sago. This food plant is needed to meet the basic needs and nutrition of the population [1]. The Indonesian population mostly consumes rice (paddy) as a daily staple food, even though many other food crops that can be used as a staple food such as corn.

Corn is a staple food that is often consumed by Indonesian people besides rice or rice, especially in Eastern Indonesia. More than 50% of the maize production is used for consumption and the rest for livestock. Corn is a source of carbohydrates. Also, corn is rich in other components such as dietary fiber, essential fatty acids, isoflavones, and minerals. Corn is still consumed as a staple food or as a mixture of rice Corn can be used as a variety of processed food products such as corn oil, cornflour, and other food [2]

Indonesian people tend to like to consume foods that have high levels of fat, salt, and carbohydrates such as ready-to-eat food. In fast, food there are also various physical appearances such as the color and texture of the food that can attract consumer interest. Meanwhile, traditional foods that have nutritional levels and the appearance of food that is not good tend to be not in demand so that there is a need for development in creating a ready-to-eat product but has good nutritional levels and appearance [3]. One of the corn products that can be processed into ready-to-eat food is tortillas. Tortilla chips are a snack that originates from southern America and is made from corn. The word tortilla itself means corn in Spanish

[4].

The development that can be done on tortilla chips is by adding vegetable flour. Vegetable flour can increase the nutritional value and taste but can also improve the appearance of the product such as the color and texture of the tortilla. Tortillas with the addition of vegetables can also increase the economic value of vegetables, especially green spinach, red spinach, beets, and celery which are usually only processed as processed food for vegetables to accompany rice.

2. Material and Methods

2.1. Plant Material

The materials used in this study were corn flour, red spinach flour, and beetroot flour with the brand 'Hasil Bumiku', salt, flavoring ‘Royco’, powdered sugar, water, garlic powder, pepper, and water.

2.2. Sample Preparation

Tortilla chips in this study were made using various variations in the concentration between corn flour and vegetable flour. The vegetable flour used includes red spinach flour, beet flour, green spinach flour, and celery flour. The variations in the concentration of fortified vegetable flour in the manufacture of tortilla chips are 0% (control), 10%, 25%, and 50%.

The formulation of cornflour and various concentrations of vegetable flour is then added with supporting ingredients such as salt, refined sugar, ground pepper, garlic powder, and flavorings. The flour formulations and supporting materials for making tortilla chips can be seen in Table 1. The mixture of cornflour and vegetable flour is given 25 ml hot water and then kneaded. The kneaded dough is then steamed for 10 minutes, then added with hot water again as much as 25ml, and then steamed again for 10 minutes. After steaming, the dough is then flattened to form a sheet using a rolling pin and cut into a square. The dough that has been formed is heated into an oven at 100 ° C for 1 hour then the dough is stored for further analysis.

2.3. Analysis Tortilla Chips

The analytical methods used in this study include color testing with the Hunter method chromameter [5] and the fracture strength test using the Lloyd Universal Testing Machine method [6]. The experimental design used a completely randomized design (CRD) with a factor of variation in the formulation of cornflour, red spinach flour, and beetroot flour with 2 repeat analyzes.

Table 1. Formulation tortilla chips

Sample	**F1 (90:10) (gram)**	**F2 (75:25) (gram)**	**F3 (50:50) (gram)**
Cornflour	45	37,5	25
Red spinach flour/beetroot flour /spinach flour /celery flour	5	12,5	25
Sugar	5	5	5
Salt	1	1	1
Garlic powder	0,5	0,5	0,5
Pepper powder	0,25	0,25	0,25
Flavoring	1	1	1
Water	50	50	50

Source: [7], [8] with modification

3. Result and discussion

3.1 Color analysis of tortilla chips

Color is one of the important parameters in a food product. Color analysis of tortilla chips samples using Hunter's lab calorimetric system method. This method has a principle like a spectrophotometer which measures the reflectance with filters X, Y, and Z which will be converted to values L, a, and b. The color characteristic L (light) indicates the brightness with values in the range 0 (black) to 100 (white). A value indicates a mixed chromatic color of red-green where a positive value (0-100) indicates red color while a negative value (0 - (- 80)) indicates a green color. The b value shows the chromatic color of the blue-yellow mixture where the positive b value (0-70) shows the yellow color while the negative b value (0 - (-70)) shows the blue color [9].

Table 2. Color analysis of vegetable tortilla chips

Sample	L	a	b
Kontrol	46,74	2,00	15,31
BM10	38,91	3,60	7,81
BM25	35,97	2,94	5,86
BM50	35,81	2,68	5,44
B10	38,64	9,37	7,46
B25	33,09	4,64	3,37
B50	33,34	5,43	3,67
BI10	40,31	0,75	10,01
BI25	35,77	0,64	6,32
BI50	35,11	0,62	5,7
S10	44,44	-0,02	12,97
S25	37,75	0,34	7,56
S50	37,84	0,33	8,12

[a]Note: BM (red spinach), B (beetroot), BI (spinach), and S (celery)

Table 2. shows that the color test on tortilla chips has an L value in the range 33.09-46.74 where the highest L value is found in the control. The higher the L value on the tortilla chips, the resulting color brightness increased. The addition of vegetable flour to tortilla chips tends to reduce the L value of tortilla chips. This is because the added vegetable flour has a darker color pigment compared to corn flour, which is red from the addition of red spinach and beet flour and green from green spinach and celery flour. The lowest value for tortilla chips was B25. The color of the vegetable tortilla can be seen in **Figure 1.**

Corn flour has carotene pigments, which produce a bright yellow [10]. Red spinach and beetroot flour have red pigments and green spinach flour and celery flour have green pigments where these two colors tend to have a lower brightness level compared to the brightness of cornflour. Also, the heating treatment of the roasting process can cause the color of the tortilla chips to turn brown and slightly darker. According to [11], the presence of a roasting process in a food product will affect the color, the longer the food product is roasted, the color of the product will be brown due to the Maillard reaction or non-enzymatic browning and caramelization. The presence of a Maillard reaction or excessive caramelization in tortillas can degrade the quality of the tortilla chips.

The value of the vegetable tortilla chips shows a red-green chromatic color. **Table 2** shows that the

value of an on these vegetable chips has a range of -0.02 to 9.37 where the highest value is at B10. Tortilla chips with the addition of red spinach and beet flour tend to have a higher value because the two vegetable flour contains red pigment. Tortillas that are added with beet flour or red spinach flour will change the color of the tortilla, which is usually bright yellow, to reddish. This is because red spinach contains lutein where it has a dark yellow to the reddish pigment that can change the color of food and red beets contain the pigment betacyanin which also forms a red-purple color [12], [13].

Tortilla chips with the addition of green spinach and celery flour tend to have low value because these tortillas show more chromatic green color. The more green spinach and celery flour you add to the tortilla, the stronger the green color will be. Celery and green spinach have chlorophyll pigments which produce a yellowish-green color so that food products produced using this flour will also be green [14].
The b value on the vegetable tortilla chips shows a yellow-yellow chromatic color. **Table 2** shows that the vegetable tortilla chips have a value range of 3.37-15.31 where the highest b value is found in control tortillas. The more vegetable flour you add to the tortilla, the less b value tends to be in the tortilla. Corn contains carotenoids which produce a yellow pigment [15].

The appearance of color in a product is one of the parameters that can determine the quality of the product. According to [16], the quality standard for the color of chips can be grouped into three types, namely the desired food color, the color that is still allowed, and the color that is not desired and consumers tend to have the desired color group and are still allowed as products that have Good quality and can be consumed. The color of chips that are pale and too dark/burnt will be considered a product of poor quality by consumers and tend not to be desirable.

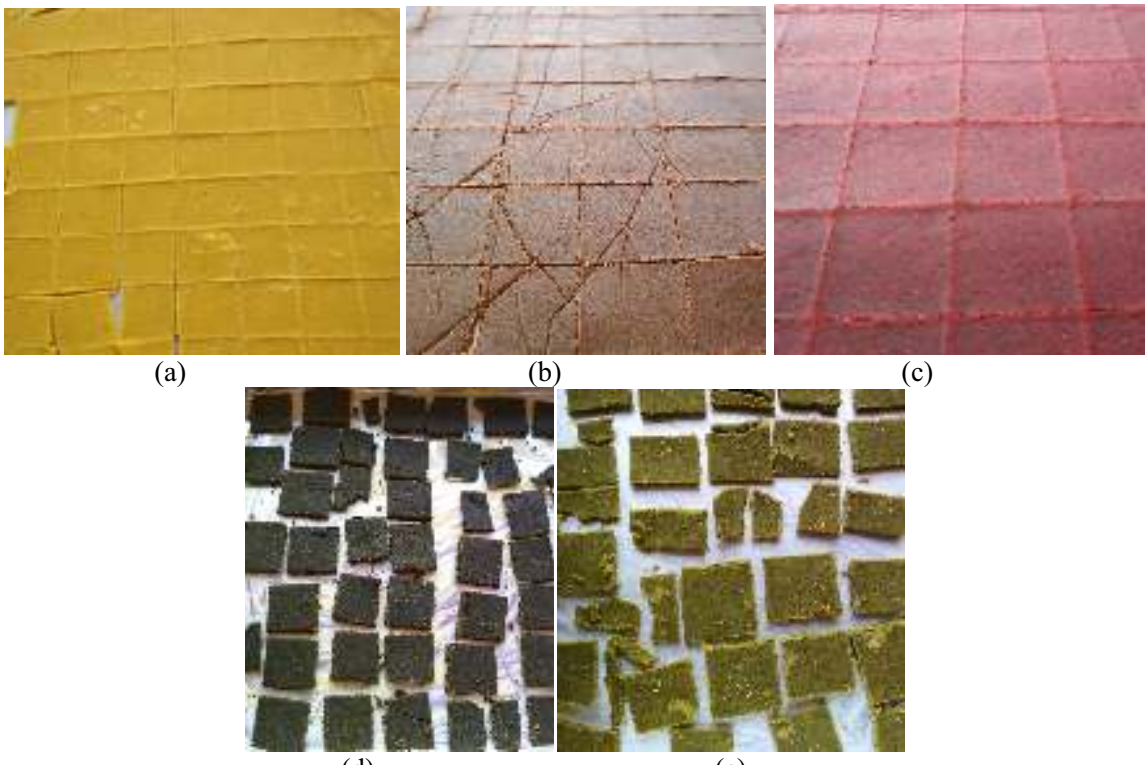

Figure 1. (a). Control vegetable chips (b) Red spinach tortilla chips (c) Beetroot tortilla chips (d) Spinach tortilla chips (e) Celery tortilla chips

3.2. Texture Analysis of Tortilla Chips

The quality of snack food products can be seen from several parameters, namely chemical-physical properties in the form of nutritional value and physical properties such as texture and appearance of the product. This physical parameter refers to the level of texture crispiness of food products obtained from various tests so that it can be accepted by consumers [17]. The texture parameters of food are influenced by the ingredients they are made of and can be evaluated using instruments or by sensory analysis. The physical analysis carried out on this vegetable tortilla was a texture hardness test using the Universal Testing Machine (UTM) method. Hardness is one of the parameters in determining the quality and acceptance of consumers for foodstuffs [18]. The fracture power of a food ingredient, especially in snack products, is closely related to the texture and fragility characteristics of the snack product. Fbreak shows the fractured power of the sample. Fbreak is the maximum force required to press the product until the product breaks for the first time and is related to the hardness of a product. The harder texture of the tortilla chips produced, the higher the hardness level of the chips so that the texture of chips produced is also less crunchy [19].

Table 3. Texture analysis tortilla chips

Sample	FBreak
Control	3,12±0,15[cd]
BM10	2,88±0,09[bc]
BM25	2,34±0,02[ab]
BM50	22,58±0,15[i]
B10	1,83±0,03[a]
B25	8,92±0,07[f]
B50	12,14±0,79[h]
BI10	4,48±0,06[e]
BI25	3,58±0,21[d]
BI50	10,75±0,06[g]
S10	2,69±0,11[bc]
S25	27,27±0,04[j]
S50	10,50±0,44[g]

[a]Notes Numbers followed by the same letter in the same column are not significantly different at 5%
[b]BM (red spinach), B (beetroot), BI (spinach), and S (celery)

Table 3 shows the texture of the vegetable tortilla chips with Fbreak in the range 1-27 where the highest Fbreak was at S25 at 27.27 and the smallest at B10 at 1.83. Based on statistical results, the texture of the control tortilla chips was significantly different from the texture of the tortilla chips fortified with vegetable flour. This shows that the addition of vegetable flour affects the texture of the tortilla chips.

The higher the concentration of vegetable flour added to the tortilla chips, the higher the Fbreak value or the tougher texture. The level of crispiness of the tortillas can be indicated by a small or low Fbreak value, where the less the Fbreak value, the better or more crispy the tortilla is. This is due to a large amount of moisture that comes out of the gelatinized corn starch granules due to heat treatment so that cavities are formed in the product which makes these tortilla chips have a crunchy texture [20]. The level of the crispness of the texture and thickness of the tortilla chips varies greatly because in the manufacture of tortillas there are no special standards in the processing process so that differences in raw materials, the concentration of raw materials used, and the stages of making tortilla chips can make the

resulting tortilla chips vary [17]

The fiber content in the tortilla ingredients also affects the crunchiness of the tortilla chips. Fiber is a polysaccharide found in food and has a function as a texture enhancer. The higher the fiber content in a food product, the stronger the resulting texture. If the texture of the chip product is getting stronger, the resulting texture of the chips will be harder and will have high fracture power. A chip product has good quality if it has low fracture power, resulting in crispy [21]. This is consistent with the results of research where the higher the concentration of vegetable flour was added, the higher the Fbreak value or the breaking strength of the tortilla so that the texture was getting harder. Fresh red spinach has a fiber content of 5.9-9.1% and when used as flour it is 9.45% while beetroot is 1.9-2.1% [22]–[24].

Figure 2. Tortilla texture analysis with Universal Testing Machine (UTM)

4. Conclusion

The addition of vegetable flour to the tortilla chips affect the color and texture of the tortillas. The color of the tortilla will change according to the color of the pigment in the vegetable flour. The red spinach and beet tortillas are red and the green spinach and celery tortillas are green. The texture of the vegetable tortilla chips will get tougher as the concentration of vegetable flour is added. The best and crunchy texture of the tortilla is found in the 10% beet flour fortified tortilla.

References

[1] P. Erviyana, “Faktor-faktor yang mempengaruhi produksi tanaman pangan jagung di Indonesia,” *JEJAK: Jurnal Ekonomi dan Kebijakan*, vol. 7, no. 2, 2014.

[2] B. Krisnamurthi, “Manfaat jagung dan peran produk bioteknologi serealia dalam menghadapi krisis pangan, pakan dan energi di indonesia,” *Prosiding Pekan Serealia Nasional*, pp. 1–9, 2010.

[3] S. Suarni and M. Yasin, “Jagung sebagai sumber pangan fungsional,” 2019.

[4] Y. Andriyani and H. Syahrumsah, “Nilai gizi dan sifat mutu sensoris tortilla chips,” p. 6, 2017.

[5] J. B. Hutchings, “Measurement of appearance properties other than colour,” in *Food Colour and Appearance*, Springer, 1994, pp. 327–366.

[6] F. Nourian and H. S. Ramaswamy, "Kinetics of quality change during cooking and frying of potatoes: Part I. Texture," *Journal of food process engineering*, vol. 26, no. 4, pp. 377–394, 2003.
[7] L. A. Ochoa-Martínez, K. Castillo-Vázquez, J. de Dios Figueroa-Cárdenas, J. Morales-Castro, and J. A. Gallegos-Infante, "Quality evaluation of tortilla chips made with corn meal dough and cooked bean flour," *Cogent Food & Agriculture*, vol. 2, no. 1, p. 1136017, 2016.
[8] S. Y. S. Rahayu, "Pemanfaatan tepung cangkang kerang sebagai bahan fortifikan pada keripik jagung yang dikonsumsi anak dan remaja," *FITOFARMAKA: Jurnal Ilmiah Farmasi*, vol. 5, no. 2, pp. 41–48, 2015.
[9] J. Jamaluddin, B. Rahardjo, P. Hastuti, and R. Rochmadi, "Model perubahan warna keripik buah selama penggorengan vakum," *Agritech*, vol. 31, no. 4, 2011.
[10] M. E. Papunas, G. S. Djarkasi, and J. C. Moningka, "Karakteristik fisikokimia dan sensoris flakes berbahan baku tepung jagung (Zea mays L), tepung pisang goroho (Musa acuminafe, sp) dan tepung kacang hijau (Phaseolus radiates)," in *Cocos*, 2013, vol. 3, no. 5.
[11] N. Hadi, Y. Yusmarini, and R. Efendi, "Pemanfaatan tepung biji nangka dan tepung jagung dalam pembuatan flakes," PhD Thesis, Riau University, 2017.
[12] H. Y. Leong, P. L. Show, M. H. Lim, C. W. Ooi, and T. C. Ling, "Natural red pigments from plants and their health benefits: A review," *Food Reviews International*, vol. 34, no. 5, pp. 463–482, 2018.
[13] T. D. Suryaningrum, H. E. Irianto, and D. Ikasari, "Characteristics of kamaboko from catfish (Clarias gariepinus) surimi processed with carrot and beet root as filler and natural food colorants," *Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology*, vol. 10, no. 3, pp. 99–108, 2015.
[14] H.-E. Khoo, K. N. Prasad, K.-W. Kong, Y. Jiang, and A. Ismail, "Carotenoids and their isomers: color pigments in fruits and vegetables," *Molecules*, vol. 16, no. 2, pp. 1710–1738, 2011.
[15] A. Rosales, E. Agama-Acevedo, L. Arturo Bello-Pérez, R. Gutiérrez-Dorado, and N. Palacios-Rojas, "Effect of traditional and extrusion nixtamalization on carotenoid retention in tortillas made from provitamin a biofortified maize (Zea mays L.)," *J. Agric. Food Chem.*, vol. 64, no. 44, pp. 8289–8295, Nov. 2016, doi: 10.1021/acs.jafc.6b02951.
[16] F. Pedreschi, A. Bunger, O. Skurtys, P. Allen, and X. Rojas, "Grading of potato chips according to their sensory quality determined by color," *Food Bioprocess Technol*, vol. 5, no. 6, pp. 2401–2408, Aug. 2012, doi: 10.1007/s11947-011-0559-x.
[17] N. W. Asmoro, S. Hartati, and C. B. Handayani, "Karakteristik fisik dan organoleptik produk mocatilla chips dari tepung mocaf dan jagung," *Jurnal Ilmu Pangan dan Hasil Pertanian*, vol. 1, no. 1, pp. 63–70, 2017.
[18] W. Anggita and D. Syah, "Kajian formulasi cookies ubi jalar (Ipomoea batatas L) dengan karakteristik tekstur menyerupai cookies keladi," *Departemen Ilmu dan Teknologi Pangan*, vol. 1, 2008.
[19] N. Rakhmawati, B. S. Amanto, and D. Praseptiangga, "Formulasi dan evaluasi sifat sensoris dan fisikokimia produk flakes komposit berbahan dasar tepung tapioka, tepung

kacang merah (Phaseolus vulgaris L.) dan tepung konjac (Amorphophallus oncophillus)," *Jurnal Teknosains Pangan*, vol. 3, no. 1, 2014.
[20] A. Febrianto, B. Basito, and C. Anam, "Kajian karakteristik fisikokimia dan sensoris tortilla corn chips dengan variasi larutan alkali pada proses nikstamalisasi jagung," *Jurnal Teknosains Pangan*, vol. 3, no. 3, 2014.
[21] F. G. Winarno, "Kimia dan Pangan Gizi," *PT Gramedia. Jakarta*, 2004.
[22] F. M. Al-Subhi, "Using extrusion to prepare snacks food high nutrition value fortified with soybean and spinach for children," *Alexandria Science Exchange Journal*, vol. 41, no. APRIL-JUNE, pp. 205–213, 2020.
[23] R. Kale, A. Sawate, R. Kshirsagar, B. Patil, and R. Mane, "Studies on evaluation of physical and chemical composition of beetroot (Beta vulgaris L.)," *Int J Clin Sci*, vol. 6, no. 2, pp. 2977–79, 2018.
[24] U. Sarker and S. Oba, "Protein, dietary fiber, minerals, antioxidant pigments and phytochemicals, and antioxidant activity in selected red morph Amaranthus leafy vegetable," *Plos one*, vol. 14, no. 12, p. e0222517, 2019.

055_atika_UPINCASE_-_ATIKA_NUR_SYARIFAH.doc

by

Submission date: 25-Oct-2020 09:11PM (UTC+0700)
Submission ID: 1425752420
File name: 055_atika_UPINCASE_-_ATIKA_NUR_SYARIFAH.doc (971.5K)
Word count: 3415
Character count: 17354

The study of addition variety of vegetable flour on physical characteristics of tortilla chips

Atika Nur Syarifah[1] dan Dewi Amrih[2]
[1,2] Program Sarjana Teknologi Hasil Pertanian, Fakultas Pertanian, Universitas PGRI Yogyakarta, Indonesia
atikansyarifah@upy.ac.id

Abstract. Tortilla chips are a snack product made from corn. Tortilla chips generally have a bright yellow color with a crispy texture. Variations in the manufacturing process are needed so that the resulting tortillas have more attractive colors and better textures. The purpose of this study was to determine the effect of the substitution of cornflour with various variations of vegetable flour on the appearance of the color and texture of tortillas. This study uses a completely randomized design (CRD) with two factors and two replications of the analysis. The first factor is the type of vegetable flour, red spinach flour, beets, green spinach, and celery. The second factor was the concentration of vegetable flour substituted in making tortilla chips, namely 10%, 25%, and 50%. The analysis used was the Hunter Hutching method color test and texture test using the Universal Testing Machine (UTM). The results showed that the highest L value of the color test was in the control tortilla of 46.74. The addition of vegetable flour decreases the amount of L or brightness, where vegetable flour has a color pigment that makes tortillas reduce brightness. The value of a color chormatic of red spinach tortilla and beets have a higher value than the control tortilla, green spinach, and celery, which shows that the red spinach and beet tortillas have bright red pigment. The control tortilla b has the highest value followed by green spinach and celery tortillas. The tortilla chips texture test can be seen from the amount of the Fbreak. The lowest Fbreak value found in red beet tortillas is 1.83, which shows that the beetroot tortilla has the most crispy texture compared to other vegetable tortillas and control. The higher concentration of vegetables flour added, the higher the Fbreak value indicates the harder the tortilla texture.

1. Introduction

Indonesia is an agricultural country that has the potential of various and abundant natural resources. The number of rice fields in Indonesia until 2014 was 7.6 million hectares which have the potential to be planted with various types of food crops such as rice, corn, cassava, and sago. This food plant is needed to meet the basic needs and nutrition of the population [1]. The Indonesian population mostly consumes rice (paddy) as a daily staple food, even though many other food crops that can be used as a staple food such as corn.

Corn is a staple food that is often consumed by Indonesian people besides rice or rice, especially in Eastern Indonesia. More than 50% of the maize production is used for consumption and the rest for livestock. Corn is a source of carbohydrates. Also, corn is rich in other components such as dietary fiber, essential fatty acids, isoflavones, and minerals. Corn is still consumed as a staple food or as a mixture of rice Corn can be used as a variety of processed food products such as corn oil, cornflour, and other food [2]

Indonesian people tend to like to consume foods that have high levels of fat, salt, and carbohydrates such as ready-to-eat food. In fast, food there are also various physical appearances such as the color and texture of the food that can attract consumer interest. Meanwhile, traditional foods that have nutritional levels and

the appearance of food that is not good tend to be not in demand so that there is a need for development in creating a ready-to-eat product but has good nutritional levels and appearance [3]. One of the corn products that can be processed into ready-to-eat food is tortillas. Tortilla chips are a snack that originates from southern America and is made from corn. The word tortilla itself means corn in Spanish [4]

The development that can be done on tortilla chips is by adding vegetable flour. Vegetable flour can increase the nutritional value and taste but can also improve the appearance of the product such as the color and texture of the tortilla. Tortillas with the addition of vegetables can also increase the economic value of vegetables, especially green spinach, red spinach, beets, and celery which are usually only processed as processed food for vegetables to accompany rice.

2. Material and Methods

Plant Material. The materials used in this study were corn flour, red spinach flour, and beetroot flour with the brand 'Hasil Bumiku', salt, flavoring 'Royco', powdered sugar, water, garlic powder, pepper, and water.

Sample Preparation. Tortilla chips in this study were made using various variations in the concentration between corn flour and vegetable flour. The vegetable flour used includes red spinach flour, beet flour, green spinach flour, and celery flour. The variations in the concentration of fortified vegetable flour in the manufacture of tortilla chips are 0% (control), 10%, 25%, and 50%.

The formulation of cornflour and various concentrations of vegetable flour is then added with supporting ingredients such as salt, refined sugar, ground pepper, garlic powder, and flavorings. The flour formulations and supporting materials for making tortilla chips can be seen in Table 1. The mixture of cornflour and vegetable flour is given 25 ml hot water and then kneaded. The kneaded dough is then steamed for 10 minutes, then added with hot water again as much as 25ml and then steamed again for 10 minutes. After steaming, the dough is then flattened to form a sheet using a rolling pin and cut into a square. The dough that has been formed is heated into an oven at 100 ° C for 1 hour then the dough is stored for further analysis.

Analysis Tortilla Chips. The analytical methods used in this study include color testing with the Hunter method chromameter [5] and the fracture strength test using the Lloyd Universal Testing Machine method [6]. The experimental design used a completely randomized design (CRD) with a factor of variation in the formulation of cornflour, red spinach flour, and beetroot flour with 2 repeat analyzes.

Table 1. Formulation tortilla chips

Sampe	F1 (90:10) (gram)	F2 (75:25) (gram)	F3 (50:50) (gram)
Cornflour	45	37,5	25
Red spinach flour/beetroot flour /spinach flour /celery flour	5	12,5	25
Sugar	5	5	5
Salt	1	1	1
Garlic powder	0,5	0,5	0,5
Pepper powder	0,25	0,25	0,25
Flavoring	1	1	1
Water	50	50	50

Source: [7], [8] with modification

3. Result and discussion

3.1 Color analysis of tortilla chips

Color is one of the important parameters in a food product. Color analysis of tortilla chips samples using Hunter's lab calorimetric system method. This method has a principle like a spectrophotometer which measures the reflectance with filters X, Y, and Z which will be converted to values L, a, and b. The color characteristic L (light) indicates the brightness with values in the range 0 (black) to 100 (white). A value indicates a mixed chromatic color of red-green where a positive value (0-100) indicates red color while a negative value (0 - (- 80)) indicates a green color. The b value shows the chromatic color of the blue-yellow mixture where the positive b value (0-70) shows the yellow color while the negative b value (0 - (-70)) shows the blue color [9].

Table 2. Color analysis of vegetable tortilla chips

Sample	L	a	b
Kontrol	46,74	2,00	15,31
BM10	38,91	3,60	7,81
BM25	35,97	2,94	5,86
BM50	35,81	2,68	5,44
B10	38,64	9,37	7,46
B25	33,09	4,64	3,37
B50	33,34	5,43	3,67
BI10	40,31	0,75	10,01
BI25	35,77	0,64	6,32
BI50	35,11	0,62	5,7
S10	44,44	-0,02	12,97
S25	37,75	0,34	7,56
S50	37,84	0,33	8,12

[a]Note: BM (red spinach), B (beetroot), BI (spinach), and S (celery)

Table 2. shows that the color test on tortilla chips has an L value in the range 33.09-46.74 where the highest L value is found in the control. The higher the L value on the tortilla chips, the resulting color brightness increased. The addition of vegetable flour to tortilla chips tends to reduce the L value of tortilla chips. This is because the added vegetable flour has a darker color pigment compared to corn flour, which is red from the addition of red spinach and beet flour and green from green spinach and celery flour. The lowest value for tortilla chips was B25. The color of the vegetable tortilla can be seen in **Figure 1.**

Corn flour has carotene pigments, which produce a bright yellow [10]. Red spinach and beetroot flour have red pigments and green spinach flour and celery flour have green pigments where these two colors tend to have a lower brightness level compared to the brightness of cornflour. Also, the heating treatment of the roasting process can cause the color of the tortilla chips to turn brown and slightly darker. According to [11], the presence of a roasting process in a food product will affect the color, the longer the food product is roasted, the color of the product will be brown due to the Maillard reaction or non-enzymatic browning and caramelization. The presence of a Maillard reaction or excessive caramelization in tortillas can degrade the quality of the tortilla chips.

The value of the vegetable tortilla chips shows a red-green chromatic color. **Table 2** shows that the value of an on these vegetable chips has a range of -0.02 to 9.37 where the highest value is at B10. Tortilla chips with the addition of red spinach and beet flour tend to have a higher value because the two vegetable flour contains red pigment. Tortillas that are added with beet flour or red spinach flour will change the color of the tortilla, which is usually bright yellow, to reddish. This is because red spinach

contains lutein where it has a dark yellow to the reddish pigment that can change the color of food and red beets contain the pigment betacyanin which also forms a red-purple color [12], [13].
Tortilla chips with the addition of green spinach and celery flour tend to have low value because these tortillas show more chromatic green color. The more green spinach and celery flour you add to the tortilla, the stronger the green color will be. Celery and green spinach have chlorophyll pigments which produce a yellowish-green color so that food products produced using this flour will also be green [14].
The b value on the vegetable tortilla chips shows a yellow-yellow chromatic color. **Table 2** shows that the vegetable tortilla chips have a value range of 3.37-15.31 where the highest b value is found in control tortillas. The more vegetable flour you add to the tortilla, the less b value tends to be in the tortilla. Corn contains carotenoids which produce a yellow pigment [15].
The appearance of color in a product is one of the parameters that can determine the quality of the product. According to [16], the quality standard for the color of chips can be grouped into three types, namely the desired food color, the color that is still allowed, and the color that is not desired and consumers tend to have the desired color group and are still allowed as products that have Good quality and can be consumed. The color of chips that are pale and too dark/burnt will be considered a product of poor quality by consumers and tend not to be desirable.

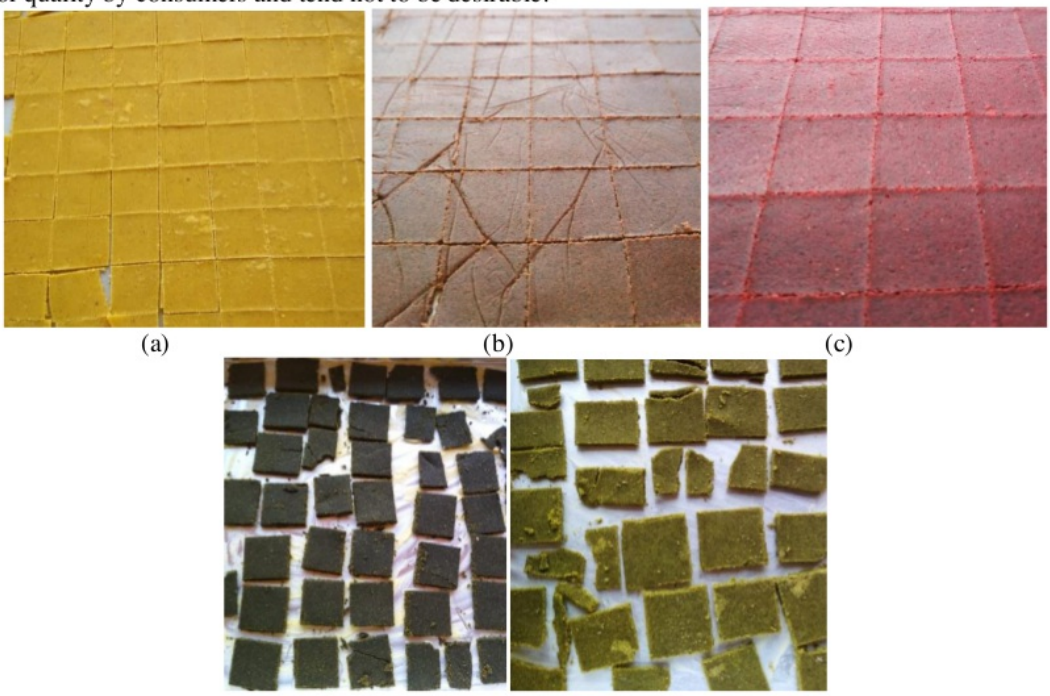

Figure 1. (a). Control vegetable chips (b) Red spinach tortilla chips (c) Beetroot tortilla chips (d) Spinach tortilla chips (e) Celery tortilla chips

3.2. Texture Analysis of Tortilla Chips

The quality of snack food products can be seen from several parameters, namely chemical-physical properties in the form of nutritional value and physical properties such as texture and appearance of the product. This physical parameter refers to the level of texture crispiness of food products obtained from

various tests so that it can be accepted by consumers [17]. The texture parameters of food are influenced by the ingredients they are made of and can be evaluated using instruments or by sensory analysis. The physical analysis carried out on this vegetable tortilla was a texture hardness test using the Universal Testing Machine (UTM) method. Hardness is one of the parameters in determining the quality and acceptance of consumers for foodstuffs [18]. The fracture power of a food ingredient, especially in snack products, is closely related to the texture and fragility characteristics of the snack product. Fbreak shows the fractured power of the sample. Fbreak is the maximum force required to press the product until the product breaks for the first time and is related to the hardness of a product. The harder texture of the tortilla chips produced, the higher hardness level of the chips so that the texture of chips produced is also less crunchy [19].

Table 3. Texture analysis tortilla chips

Sample	FBreak
Control	3,12±0,15^{cd}
BM10	2,88±0,09^{bc}
BM25	2,34±0,02^{ab}
BM50	22,58±0,15^{i}
B10	1,83±0,03^{a}
B25	8,92±0,07^{f}
B50	12,14±0,79^{h}
BI10	4,48±0,06^{e}
BI25	3,58±0,21^{d}
BI50	10,75±0,06^{g}
S10	2,69±0,11^{bc}
S25	27,27±0,04^{j}
S50	10,50±0,44^{g}

[a]Notes Numbers followed by the same letter in the same column are not significantly different at 5%
[b]BM (red spinach), B (beetroot), BI (spinach), and S (celery)

Table 3 shows the texture of the vegetable tortilla chips with Fbreak in the range 1-27 where the highest Fbreak was at S25 at 27.27 and the smallest at B10 at 1.83. Based on statistical results, the texture of the control tortilla chips was significantly different from the texture of the tortilla chips fortified with vegetable flour. This shows that the addition of vegetable flour affects the texture of the tortilla chips.

The higher the concentration of vegetable flour added to the tortilla chips, the higher the Fbreak value or the tougher texture. The level of crispiness of the tortillas can be indicated by a small or low Fbreak value, where the less the Fbreak value, the better or more crispy the tortilla is. This is due to a large amount of moisture that comes out of the gelatinized corn starch granules due to heat treatment so that cavities are formed in the product which makes these tortilla chips have a crunchy texture [20]. The level of the crispness of the texture and thickness of the tortilla chips varies greatly because in the manufacture of tortillas there are no special standards in the processing process so that differences in raw materials, the concentration of raw materials used, and the stages of making tortilla chips can make the resulting tortilla chips vary [17]

The fiber content in the tortilla ingredients also affects the crunchiness of the tortilla chips. Fiber is a polysaccharide found in food and has a function as a texture enhancer. The higher the fiber content in a food product, the stronger the resulting texture. If the texture of the chip product is getting stronger, the resulting texture of the chips will be harder and will have high fracture power. A chip product has good

quality if it has low fracture power, resulting in crispy [21]. This is consistent with the results of research where the higher the concentration of vegetable flour was added, the higher the Fbreak value or the breaking strength of the tortilla so that the texture was getting harder. Fresh red spinach has a fiber content of 5.9-9.1% and when used as flour it is 9.45% while beetroot is 1.9-2.1% [22]–[24].

Figure 2. Tortilla texture analysis with Universal Testing Machine (UTM)

4. Conclusion

The addition of vegetable flour to the tortilla chips affect the color and texture of the tortillas. The color of the tortilla will change according to the color of the pigment in the vegetable flour. The red spinach and beet tortillas are red and the green spinach and celery tortillas are green. The texture of the vegetable tortilla chips will get tougher as the concentration of vegetable flour is added. The best and crunchy texture of the tortilla is found in the 10% beet flour fortified tortilla.

References

[1] P. Erviyana, "Faktor-faktor yang mempengaruhi produksi tanaman pangan jagung di Indonesia," *JEJAK: Jurnal Ekonomi dan Kebijakan*, vol. 7, no. 2, 2014.

[2] B. Krisnamurthi, "Manfaat jagung dan peran produk bioteknologi serealia dalam menghadapi krisis pangan, pakan dan energi di indonesia," *Prosiding Pekan Serealia Nasional*, pp. 1–9, 2010.

[3] S. Suarni and M. Yasin, "Jagung sebagai sumber pangan fungsional," 2019.

[4] Y. Andriyani and H. Syahrumsah, "Nilai gizi dan sifat mutu sensoris tortilla chips," p. 6, 2017.

[5] J. B. Hutchings, "Measurement of appearance properties other than colour," in *Food Colour and Appearance*, Springer, 1994, pp. 327–366.

[6] F. Nourian and H. S. Ramaswamy, "Kinetics of quality change during cooking and frying of potatoes: Part I. Texture," *Journal of food process engineering*, vol. 26, no. 4, pp. 377–394, 2003.

[7] L. A. Ochoa-Martínez, K. Castillo-Vázquez, J. de Dios Figueroa-Cárdenas, J. Morales-Castro, and J. A. Gallegos-Infante, "Quality evaluation of tortilla chips made with corn

meal dough and cooked bean flour," *Cogent Food & Agriculture*, vol. 2, no. 1, p. 1136017, 2016.
[8] S. Y. S. Rahayu, "Pemanfaatan tepung cangkang kerang sebagai bahan fortifikan pada keripik jagung yang dikonsumsi anak dan remaja," *FITOFARMAKA: Jurnal Ilmiah Farmasi*, vol. 5, no. 2, pp. 41–48, 2015.
[9] J. Jamaluddin, B. Rahardjo, P. Hastuti, and R. Rochmadi, "Model perubahan warna keripik buah selama penggorengan vakum," *Agritech*, vol. 31, no. 4, 2011.
[10] M. E. Papunas, G. S. Djarkasi, and J. C. Moningka, "Karakteristik fisikokimia dan sensoris flakes berbahan baku tepung jagung (Zea mays L), tepung pisang goroho (Musa acuminafe, sp) dan tepung kacang hijau (Phaseolus radiates)," in *Cocos*, 2013, vol. 3, no. 5.
[11] N. Hadi, Y. Yusmarini, and R. Efendi, "Pemanfaatan tepung biji nangka dan tepung jagung dalam pembuatan flakes," PhD Thesis, Riau University, 2017.
[12] H. Y. Leong, P. L. Show, M. H. Lim, C. W. Ooi, and T. C. Ling, "Natural red pigments from plants and their health benefits: A review," *Food Reviews International*, vol. 34, no. 5, pp. 463–482, 2018.
[13] T. D. Suryaningrum, H. E. Irianto, and D. Ikasari, "Characteristics of kamaboko from catfish (Clarias gariepinus) surimi processed with carrot and beet root as filler and natural food colorants," *Squalen Bulletin of Marine and Fisheries Postharvest and Biotechnology*, vol. 10, no. 3, pp. 99–108, 2015.
[14] H.-E. Khoo, K. N. Prasad, K.-W. Kong, Y. Jiang, and A. Ismail, "Carotenoids and their isomers: color pigments in fruits and vegetables," *Molecules*, vol. 16, no. 2, pp. 1710–1738, 2011.
[15] A. Rosales, E. Agama-Acevedo, L. Arturo Bello-Pérez, R. Gutiérrez-Dorado, and N. Palacios-Rojas, "Effect of traditional and extrusion nixtamalization on carotenoid retention in tortillas made from provitamin a biofortified maize (Zea mays L.)," *J. Agric. Food Chem.*, vol. 64, no. 44, pp. 8289–8295, Nov. 2016, doi: 10.1021/acs.jafc.6b02951.
[16] F. Pedreschi, A. Bunger, O. Skurtys, P. Allen, and X. Rojas, "Grading of potato chips according to their sensory quality determined by color," *Food Bioprocess Technol*, vol. 5, no. 6, pp. 2401–2408, Aug. 2012, doi: 10.1007/s11947-011-0559-x.
[17] N. W. Asmoro, S. Hartati, and C. B. Handayani, "Karakteristik fisik dan organoleptik produk mocatilla chips dari tepung mocaf dan jagung," *Jurnal Ilmu Pangan dan Hasil Pertanian*, vol. 1, no. 1, pp. 63–70, 2017.
[18] W. Anggita and D. Syah, "Kajian formulasi cookies ubi jalar (Ipomoea batatas L) dengan karakteristik tekstur menyerupai cookies keladi," *Departemen Ilmu dan Teknologi Pangan*, vol. 1, 2008.
[19] N. Rakhmawati, B. S. Amanto, and D. Praseptiangga, "Formulasi dan evaluasi sifat sensoris dan fisikokimia produk flakes komposit berbahan dasar tepung tapioka, tepung kacang merah (Phaseolus vulgaris L.) dan tepung konjac (Amorphophallus oncophillus)," *Jurnal Teknosains Pangan*, vol. 3, no. 1, 2014.
[20] A. Febrianto, B. Basito, and C. Anam, "Kajian karakteristik fisikokimia dan sensoris tortilla corn chips dengan variasi larutan alkali pada proses nikstamalisasi jagung," *Jurnal Teknosains Pangan*, vol. 3, no. 3, 2014.
[21] F. G. Winarno, "Kimia dan Pangan Gizi," *PT Gramedia. Jakarta*, 2004.

[22] F. M. Al-Subhi, “Using extrusion to prepare snacks food high nutrition value fortified with soybean and spinach for children,” *Alexandria Science Exchange Journal*, vol. 41, no. APRIL-JUNE, pp. 205–213, 2020.
[23] R. Kale, A. Sawate, R. Kshirsagar, B. Patil, and R. Mane, “Studies on evaluation of physical and chemical composition of beetroot (Beta vulgaris L.),” *Int J Clin Sci*, vol. 6, no. 2, pp. 2977–79, 2018.
[24] U. Sarker and S. Oba, “Protein, dietary fiber, minerals, antioxidant pigments and phytochemicals, and antioxidant activity in selected red morph Amaranthus leafy vegetable,” *Plos one*, vol. 14, no. 12, p. e0222517, 2019.

055_atika_UPINCASE_-_ATIKA_NUR_SYARIFAH.doc

ORIGINALITY REPORT

0%	0%	0%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

Exclude quotes	On	Exclude matches	< 1%
Exclude bibliography	On		