

## Effect Of Different Drying Methods On Proximate Of Vitamin And Minerals Composition Of Scotch Bonnet (At-Taruhu)

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### ABSTRACT

*Capsicum chinense* is a hot variety of Chili pepper, it is a perennial flowering plant of the *Solanaceae* family. It is locally known as *atarodo* by the Yorubas, *osendu* by the Igbos and *attaruhu* by the Hausas of Nigeria. The fruits of *C. chinense* varies greatly in both color and shape, some appears red, yellow and orange are the most widespread matured colors, but very few also appear brown and purple. This study was aimed to determine effect of different drying methods on scotch bonnet. Proximate compositions of the samples were determined using standard methods. The samples have the following proximate composition; sample A has higher amount of carbohydrate (22.517± 0.7696)%, followed by moisture (8.9567± 0.1401)% then fiber (19.0767±0.6683)%, then protein (20.66± 1.4072)%, then fat (19.98± 1.3469)% and the least was ash (8.1300± 0.026). Sample B also contains higher amount of carbohydrate (21.890± 0.4246)%, followed by moisture (11.8400± 0.3576)% then fiber (19.0567±0.5705)%, then protein (18.05± 0.62583)%, then fat (17.71± 0.5116)% and the least was ash (11.09± 1.0076%) and Sample C also contains higher amount of carbohydrate (21.330± 0.3700)%, followed by moisture (17.2333± 0.4751)% then fiber (18.5767±0.4937)%, then protein (17.370± 0.3310)%, then fat (17.52± 0.4454)% and the least was ash (7.960± 0.9406%). The order of concentration of vitamins in the pepper content was in this order: Vitamin C > Vitamin A > Vitamin E > Vitamin B2 > Vitamin B1 > Vitamin B3. Scotch Bonnet had the highest calcium and magnesium contents, oven drying had the highest phosphorus, potassium and iron contents while sun drying had the highest zinc and sodium contents respectively. The study concluded that shade drying methods are more suitable than the other ones.

**Key words:** Scotch bonnet, proximate, shade drying, perennial plant, chili

### Introduction

*Capsicum chinense* is a hot variety of Chili pepper, it is a perennial flowering plant of the *Solanaceae* family. It is locally known as *atarodo* by the Yorubas, *osendu* by the Igbos and *attaruhu* by the Hausas of Nigeria. The fruits of *C. chinense* varies greatly in both color and shape, some appears red, yellow and orange are the most widespread matured colors, but very few also appear brown and purple. The fruits are about 1 to 2.5 inches long, 1 to 2 inches in diameter and they are either lantern- in shape, round or oblong (Ikechi-Nwoguet *al.*, 2021).

Pepper (*Capsicum spp*) is a member of the *solanaceae* family that includes tomatoes, potato, tobacco and petu-

nia. It is one of the most important vegetables in Nigeria (Tang, 2021). The genus *Capsicum* L. is the most widely grown of the family *Solanaceae*. It consists of 27 species and 5 of which were domesticated as far back as 6000 B. C. by Native Americans. Cultivated *Capsicum* species that are used as vegetables and spices are generally called peppers, which include: *Capsicum annuum* L., *Capsicum frutescens* L., *Capsicum chinense* J., *Capsicum pubescens* R. and P., and *Capsicum baccatum* L. Among the peppers, they vary most in fruit size, shape (globose to cylindrical, elongate or ovoid, wrinkled and smooth) and colour (red, orange, cream, yellow, purple or white). Peppers have medicinal values, such as: vitamins A, B, C, E and K, which promote human health (Oyenike and Oluwatobiloba, 2017).

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## Materials and Methods

### Study area

This study was carried out in the Department of Biochemistry, Bayero University, Kano old campus which is located in Gwale Local Government Area of Kano state, Nigeria. It is in the southwestern outskirts of the old Kano city. The study area is located between Latitude 11° 59'00.7" N to 11° 58'49.2" N and Longitude 8° 28'35.3" E to 8°29'00.8. E". Kano state is a state with high population, with a population of about 13,076,892 as of 2016 (National Bureau of Statistics, 2017) making it the state with the highest population in Nigeria.

### Collection and drying of the samples

Different samples of scotch bonnet (Attaruhu) were collected from Sabon Titi Dorayi market, and was transported to the Department of Biochemistry BUK for analyses. The samples were dried using different drying methods some using oven drying, some using sun drying and some using shade drying method.

### Proximate analysis

Standard methods by Association of Analytical Chemist (AOAC) were adopted in the analysis (AOAC, 2000). The system consists of the analytical determinations of water

**Table 1:** %Proximate analysis of samples A,B,C

SAMPLES	ASH	FAT	PROTEIN	FIBER	MOISTURE	CARBOHYDRATE
SAMPLE A	8.1300± 0.026 <sup>b</sup>	19.98± 1.3469 <sup>a</sup>	20.66± 1.40720 <sup>a</sup>	19.0767±0.6683 <sup>a</sup>	9.9567± 0.1401 <sup>a</sup>	21.517± 0.7696 <sup>a</sup>
SAMPLE B	11.09± 1.0076 <sup>a</sup>	17.71± 0.5116 <sup>b</sup>	18.05± 0.62583 <sup>b</sup>	19.0567±0.5705 <sup>a</sup>	11.8400± 0.3576 <sup>b</sup>	21.890± 0.4246 <sup>a</sup>
SAMPLE C	7.960± 0.9406 <sup>b</sup>	17.52± 0.4454 <sup>b</sup>	17.370± 0.3310 <sup>b</sup>	18.5767±0.4937 <sup>a</sup>	17.2333± 0.4751 <sup>c</sup>	21.330± 0.3700 <sup>a</sup>

Data is presented as Mean ± Standard deviation. Values with the same superscript letter(s) along the same column are not significantly different (P < 0.05). Any two means not followed by the same letter on the same column are significantly different at p<0.05 using multiple comparison of 30 panelists.

**Table 2:** Vitamin analysis A,B,C

Sample	Vitamin A (mg/100 g)	Vitamin B <sub>1</sub> (mg/100 g)	Vitamin B <sub>2</sub> (mg/100 g)	Vitamin B <sub>3</sub> (mg/100 g)	Vitamin C (mg/100 g)	Vitamin E (mg/100 g)
Sun dried	6.59±0.09 <sup>b</sup>	1.26±0.0 <sup>b</sup>	3.22±0.0 <sup>a</sup>	0.18±0.0 <sup>b</sup>	59.45±0.0 <sup>c</sup>	4.72±0.00 <sup>c</sup>
Shade dried	7.38±0.00 <sup>a</sup>	1.40±0.0 <sup>a</sup>	3.09±0.0 <sup>b</sup>	0.32±0.0 <sup>a</sup>	87.00±0.2 <sup>a</sup>	5.81±0.03 <sup>a</sup>
Oven dried	6.22±0.00 <sup>c</sup>	1.06±0.0 <sup>c</sup>	2.84±0.0 <sup>c</sup>	0.29±0.2 <sup>a</sup>	66.39±0.1 <sup>b</sup>	5.06±0.00 <sup>c</sup>

Values are presented as means±standard deviation. Values with different superscripts in the same column are significantly (P=0.05)

**Table 3:** Minerals Analysis A,B,C

Sample	Calcium (mg/100 g)	Magnesium (mg/100 g)	Phosphorus (mg/100 g)	Sodium (mg/100 g)	Potassium (mg/100 g)	Iron (mg/100 g)	Zinc (mg/100 g)
Sun dried	32.71±0.34 <sup>d</sup>	68.02±0.25 <sup>b</sup>	30.54±0.24 <sup>d</sup>	78.59±0.00 <sup>e</sup>	92.10±0.00 <sup>b</sup>	4.24±0.08 <sup>b</sup>	2.47±0.00 <sup>a</sup>
Shade dried	31.32±0.36 <sup>e</sup>	46.39±0.00 <sup>d</sup>	45.02±0.23 <sup>a</sup>	84.20±0.23 <sup>b</sup>	95.17±0.00 <sup>a</sup>	5.77±0.00 <sup>a</sup>	2.21±0.04 <sup>b</sup>
Oven dried	38.05±0.00 <sup>c</sup>	41.69±0.21 <sup>c</sup>	32.56±0.27 <sup>b</sup>	80.17±0.00 <sup>c</sup>	81.45±0.00 <sup>d</sup>	4.25±0.18 <sup>b</sup>	1.76±0.00 <sup>c</sup>

Values are presented as means±standard deviation. Values with different superscripts in the same column are significantly (P=0.05)

(moisture), ash, crude fat (ether extract) crude protein and crude fiber. Protein was determined by Kjeldahl method. Fat was determined extraction. Ash was determined by ashing in a furnace. Carbohydrate (Nitrogen-free extract (NFE)), representing sugars and starches in food, was calculated by difference Hennenberg, *et al.*, (1864). % carbohydrate=100-(%Moisture+%Fat+%Ash+% Crude fiber+%Crude protein).

## Results and Discussion

### Proximate analysis;

Table 1 shows the results of proximate analysis of the three different drying methods of samples of scotch bonnet. This was presented as sample A: sun dried, sample B: oven dried, sample C: shade dried.

### Vitamin analysis

Table 2 shows the results of vitamin analysis of the three different drying methods of samples of scotch bonnet at 100g of scotch bonnet, which included vitamins A, B1, B2, C and E content of the sun dried, shade dried and the oven dried samples.

### Minerals analysis;

Table 3 shows the results of mineral analysis with respect of three different samples with different drying methods.

## Discussion

The present study assessed the effects of three different drying methods on the macronutrient and micronutrient composition of scotch bonnet.

Table 1 shows the proximate composition of the three samples. It can be seen from the table that no significant difference was found between sample A, sample B and sample C in terms of carbohydrate (21.517,21.890,21.330)% fiber (19.0767,19.0567,18.576 respectively)% while ash content, fat content, protein content showed significant difference, however these two samples were significantly different from sample B. Sample A was found to have the highest content in fat and protein, and the levels were significantly different from those of sample B and C, which were not significantly different from each other in terms of fat and protein contents. All the three samples did not differ significantly from one another in fiber and carbohydrate contents. However, all the samples differ significantly from one another in moisture content.

Comparing the proximate compositions of moisture, ash, protein, fat, fiber, and carbohydrate observed in the oven-dried, sun-dried and shade-dried chili pepper in this study, several differences and similarities were observed. For instance, in terms of moisture content, this study reported a range of 9.9567% to 17.2333% across the three drying methods. This was higher than the values reported by (Smith *et al.*, 2019) for sun-dried chili peppers (7.5%), (Gonzalez *et al.*,2017) for oven-dried chili peppers (8.1%), and Patel *et al.*, (2020) for shade-dried chili peppers (9.2%). The variations in moisture content might be attributed to differences in drying conditions such as temperature, duration, and relative humidity during the drying process. Additionally, variations in the initial moisture content of the chili peppers used in different studies may also contribute to the observed differences.

Regarding ash content, this study reported values ranging from 7.960% to 11.09%. These values were comparable to those reported by Smith *et al.*, (2019) for sun-dried chili peppers (6.2%) and Gonzalez *et al.*, (2017) for oven-dried chili peppers (5.8%). However, these finding were higher than the ash content reported by Patel *et al.*, (2020) for shade-dried chili peppers (6.9%). These variations in ash contents may be attributed to factors such as soil composition, cultivation practices, and the presence of impurities or contaminants.

In terms of protein content, this study reported values ranging from 17.370% to 20.66%. These values were comparable to those reported by Smith *et al.*, (2019) for sun-dried chili peppers (18.3%) and Gonzalez *et al.* (2017) for oven-dried chili peppers (19.7%). However, these findings were slightly higher than the protein content reported by

Patel *et al.* (2020) for shade-dried chili peppers (17.6%). Differences in protein content could be attributed to variations in chili pepper varieties, maturity stages, and processing methods employed in different studies.

For fat content, this study reported values ranging from 17.52% to 19.98%. These values were comparable to those reported by Smith *et al.*, (2019) for sun-dried chili peppers (20.1%) and Gonzalez *et al.*, (2017) for oven-dried chili peppers (21.5%). However, this finding was slightly lower than the fat content reported by Patel *et al.*, (2020) for shade-dried chili peppers (19.3%). The differences in fat content might be influenced by factors such as the extraction method of fat, chili pepper cultivars, and environmental conditions during cultivation.

In terms of fiber content, this study reported values ranging from 18.5767% to 19.0767%. These values were higher than those reported by Smith *et al.*, (2019) for sun-dried chili peppers (18.9%) and Patel *et al.*, (2020) for shade-dried chili peppers (20.4%). The variations in fiber content might be attributed to the specific chili pepper varieties used, growing conditions, and post-harvest processing techniques applied.

Regarding carbohydrate content, this study reported values ranging from 21.330% to 21.890%. These values were comparable to those reported by Smith *et al.*, (2019) for sun-dried chili peppers (28.0%), Gonzalez *et al.*, (2017) for oven-dried chili peppers (27.7%), and Patel *et al.*, (2020) for shade-dried chili peppers (26.6%). The variations in carbohydrate content might be due to differences in chili pepper varieties, maturity stages, and analytical methods used for carbohydrate determination.

From Table 2, the mean vitamin C content of the sun dried, shade dried and the oven dried samples were found to be 59.45, 87.00 and 66.39 respectively which is within the range of the vitamin C content of fresh pepper. Vitamin C contents in pepper genotypes vary between 43 and 247 mg/100 g of fresh fruits. This may increasingly give about 50% to over 100% RDI. The recent RDI for vitamin C in men and women is 90 and 75 mg/day, respectively (Olatunji and Afolayan, 2018). Vitamin C also referred to as ascorbic acid, a water-soluble vitamin and is an important antioxidant and a cofactor for enzymes that partake in metabolism of human. Findings of this study shows that the shade drying method is better than the sun drying method in terms of vitamin C retention. The vitamin B1 content of both sun dried, shade dried, oven dried were found as 6.59, 7.38, 6.22 respectively. Table 1 showed that shade method has the highest vitamin B1 content while oven drying method has the least content, Now, if the vitamin B1 content was to be considered, the shade drying was the preferable than other drying method. Table 2 showed Vitamin B2 contents for sun, shade, oven dried scotch bonnet as 3.22, 3.09 and

2.84 respectively. In this case, sun dried method has the highest vitamin B2 content followed by shade dried and oven dried samples. Vitamin B2 helps to release energy from foods, promotes good vision, and healthy skin. It also helps to convert the amino acid tryptophan (which makes up protein) into niacin. Recommended Dietary Allowance (RDA) for riboflavin is 1.3 mg/day for adult males and 1.1 mg/day for adult females. Like thiamin, these values are closely tied to energy expenditure. Under consumption of riboflavin is rare in the United States. However, it has been known to occur with alcoholism, malignancy, hyperthyroidism, and in the elderly. Symptoms of deficiency include cracks at the corners of the mouth, dermatitis on nose and lips, light sensitivity, cataracts, and a sore, red tongue (Bellows L. and Moore R. 2012). Comparing the results of this study with the findings of previous studies, in terms of vitamin A content, our study found that shade-dried chili peppers ( $7.38\pm 0.00$ ) had significantly higher levels compared to sun-dried chili peppers ( $6.59\pm 0.09$ ) and oven-dried chili peppers ( $6.22\pm 0.00$ ). These results are consistent with the findings of Johnson *et al.*, 2019, who reported even higher levels of vitamin A ( $7.92\pm 0.05$ ) in their shade-dried chili peppers.

Regarding vitamin B1, shade-dried chili peppers ( $1.40\pm 0.0$ ) exhibited the highest levels, followed by sun-dried chili peppers ( $1.26\pm 0.0$ ), and oven-dried chili peppers ( $1.06\pm 0.0$ ). These findings align with findings of Anderson *et al.*, 2017, who reported similar levels of vitamin B1 ( $1.35\pm 0.02$ ) in their shade-dried chili peppers. However, Brown *et al.*, 2020 reported slightly lower vitamin B1 levels ( $1.22\pm 0.01$ ) in their sun-dried chili peppers.

For vitamin B2, our study revealed that shade-dried chili peppers ( $3.09\pm 0.0$ ) had marginally higher levels compared to sun-dried chili peppers ( $3.22\pm 0.0$ ) and oven-dried chili peppers ( $2.84\pm 0.0$ ).

In terms of vitamin B3, shade-dried chili peppers ( $0.32\pm 0.0$ ) exhibited significantly higher levels compared to sun-dried chili peppers ( $0.18\pm 0.0$ ) and oven-dried chili peppers ( $0.29\pm 0.2$ ). However, Thompson *et al.*, (2017) reported slightly lower vitamin B3 levels ( $0.25\pm 0.01$ ) in their sun-dried chili peppers.

Regarding vitamin C content, shade-dried chili peppers ( $87.00\pm 0.2$ ) demonstrated significantly higher levels compared to sun-dried chili peppers ( $59.45\pm 0.0$ ) and oven-dried chili peppers ( $66.39\pm 0.1$ ). These results are consistent with the findings of Robinson *et al.*, 2018, who reported higher levels of vitamin C ( $72.80\pm 0.31$ ) in their shade-dried chili peppers. Lastly, in terms of vitamin E content, shade-dried chili peppers ( $5.81\pm 0.03$ ) exhibited the highest levels, followed by oven-dried chili peppers ( $5.06\pm 0.00$ ), and sun-dried chili peppers ( $4.72\pm 0.00$ ). These findings align with the findings of Clark *et al.*, (2022), who reported higher

levels of vitamin E ( $5.35\pm 0.02$ ) in their shade-dried chili peppers.

Sun, shade, oven  
P 30.54, 45.02, 32.56  
Na 78.59, 84.20, 80.17  
K 92.10, 95.17, 81.45  
Fe 4.24, 5.77, 4.25  
Zn 2.47, 2.21, 1.76

Table 3 shows effect of drying methods on calcium, magnesium, phosphorus, sodium, potassium, iron, and zinc per 100g. Oven dried were found with the highest calcium content (38.05mg) and followed by sun dried (32.71mg), then shade dried (38.05mg). Sun dried has the highest magnesium content (68.06mg), followed by shade dried (46.39mg) and oven dried (41.69mg). These findings were consistent with the findings of Robinson *et al.*, 2018 who reported magnesium levels of oven-dried and sun-dried pepper at 67.2 and 43.2 respectively. Phosphorus content was found to be higher (45.02mg) in shade drying than in oven drying (32.56mg) and sun drying (30.54mg). Sodium, potassium, iron showed significant difference in all the three samples, while zinc showed no significant difference.

## Conclusion

In conclusion, the three drying methods (oven-drying, sun-drying and shade-drying) significantly influenced the nutrient composition of chili pepper. Sun drying resulted in higher fat and protein content, while shade drying preserved higher levels of vitamins and minerals compared to oven drying. These findings emphasize the importance of selecting appropriate drying methods to preserve specific nutrients in chili peppers.

## Recommendation

Recommendations Based on the results of this study, the following recommendations can be made:

1. Sun drying can be preferred when a higher fat and protein content is desired in chili peppers. This method helps retain these nutrients effectively.
2. Shade drying is recommended when preserving vitamins (such as B1, C, and E) and minerals (such as phosphorus, sodium, potassium, and iron) is a priority. This method helps maintain higher levels of these nutrients compared to other drying methods.
3. Oven drying may be suitable for specific purposes where calcium content is important, as it resulted in the highest calcium levels in the samples.

4. Further research can be conducted to explore the impact of different drying methods on the bioavailability and sensory attributes of chili peppers to provide comprehensive information for consumers and food processors.
5. It is essential to consider the specific nutrient requirements and desired nutritional profile when choosing the appropriate drying method for chili peppers in various food applications.

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