Research Journal of Food Science and Nutrition
Volume 9(1), pages 9-14, February 2024
Article Number: 6C3E7F222
ISSN: 2536-7080
https://doi.org/10.31248/RJFSN2023.163
https://integrityresjournals.org/journal/RJFSN

Full Length Research

Comparative analysis of the effect of different drying methods on the quality parameters of tomato powder

Adeosun, Y. M.*, Koyenikan, O. O. and Yusuf, A.

Department of Agricultural and Bio-Environmental Engineering, The Federal Polytechnic Ado-Ekiti, Ekiti State.

*Corresponding author. Email: adeosun_ym@fedpolyado.edu.ng

Received 14th November 2023; Accepted 22nd January 2024

ABSTRACT: This study investigates the impact of different drying systems on the quality parameters of tomato powder. The objective of this research is to evaluate and compare the effects of different drying methods on the quality parameters of tomato powder. Fresh matured and ripped tomatoes were procured, sorted, graded, washed and sliced with the thickness of 3 mm. The tomatoes were dried by three different methods viz. oven drying at 60°C, tent drying and open sun drying, milled into powder using kitchen blender and packed into air tight nylon bags for moisture content and quality parameters determination. The relevant test methods were used to determine quality parameters of the tomato powder. The relevant test methods were used to determine the results of the study showed that the samples have significant differences on the proximate and minerals content but between the samples. The findings show that there is no significant difference at 95% confidence interval. The R-square value of 0.535 and 0.980 for both proximate and minerals respectively are a measure of goodness of fit. It means the model explains 53 and 98% variation embedded in the response variable. There was no statistically significant difference between the samples (oven, sun and tent drying at $p > 0.05$. This suggests that any of the drying mediums can serve as a good source of drying for tomato powder production. However, since tent drying has the highest nutrients by composition, this study suggests the use of tent drying for production of tomato powder. Further research is needed in order to optimize the drying process of tomato powder and improve its quality parameters.

Keyword: Drying, quality, proximate, tomato powder, tomatoes.

INTRODUCTION

Drying is a suitable alternative for post harvest management especially in developing countries where there exist poorly established low temperature distribution and handling facilities. It is observed that over 20% of the world's perishable crops are dried to increase shelf-life and promote food security (Grabowski *et al*., 2003). It is a common technique and important aspect in food preservation, processing and can be used to produce a new form of products. Fruits and vegetables are dried to enhance storage stability, minimize packaging requirement and reduce transport weight (Sagar and Suresh Kumar, 2010). The reduction of water activity by moisture removal leads to significant reduction of weight and volume, minimizing packaging, transportation and storage costs (Maskan, 2001). Drying also alters other physical, biological and chemical properties of foods (Demiray and Tulek, 2008). Hot-air drying is one of the most frequently used operations for food dehydration (Youssef and Mokhtar, 2014). A major disadvantage associated with hot-air drying is that it takes long time even at high temperature, which may cause serious damage to the flavour, colour and nutrients in dried products (Jing *et al*., 2010; Youssef and Mokhtar, 2014). Sun drying is a well-known traditional method of drying agricultural commodities immediately after harvest since the existence of humans.

Vegetables are important items of diet in many countries, valuable sources of nutrients especially in rural areas where they contribute substantially to protein, mineral, vitamins, fiber and other nutrients which are usually in short supply in daily diets (Akanbi and Oludemi, 2004). Like other agricultural products, tomatoes are perishable and must be either consumed rapidly or preserved for later consumption. Over 10 million tons of tomatoes were produced in 2005 and tomato production rate stayed at this level in the following years. Total tomato production was closer to 11 million tons in 2008 (Tuik, 2010). Tomatoes must be evaluated by processing into different products during the high production season and drying is one of the major tomato processing technologies. Because not all fresh tomatoes can be consumed at the time of harvest, preservation provides a larger market, allowing consumers to buy the product on a year round basis. Today, sun-dried tomatoes have gained great acceptance in the food service segment and in the food industry as an ingredient. However, the sun drying industry currently faces difficulties consistently producing good quality dried tomatoes (Latapi G and Barrett, 2006). Whereas in developed countries, sun-dried tomatoes are considered a "gourmet" ingredient. For perishable commodities with very high moisture contents, dehydration results in substantial reduction in weight and bulk with consequent savings in storage and distribution costs (Mepba *et al*., 2007). Adejumo (2012) reported that a large percentage of tomatoes are usually sun dried on the bare ground to avoid wastages but such methods result in products with unattractive attributes, since the product is unprotected from the environmental factors and infestation by insects, rodents, animals etc. In this research, drying techniques were applied for drying of tomato namely oven drying, tent drying and sun drying, and also effects of these drying methods on nutrient contents of tomato were investigated. To better determine the role of tomato powder in different food applications, additional information on quality characteristics and nutrient composition, especially mineral content, are required, which have not been explored much.

MATERIALS AND METHODS

Sample preparation

Fresh tomatoes (*Lycopersicon esculentum var.* 'Himsona' [Syngenta AG]) of 4-5 cm in length were selected for study. Tomatoes were washed and cut in thin slices thickness 3 mm, divided into four lots, one was taken as control and the others were oven dried at 60°C, tent dried and sun dried. Therefore, the drying processes were monitored until the constant weight was achieved. Then milled into powder using a blender and packed in an airtight container for proximate and mineral content. Ground samples of fresh and oven dried, sun-dried and tent dried tomatoes were analyzed for their proximate composition and mineral composition using the recommended methods of AOAC (2000). The moisture content was determined by the oven drying method, ash was determined by igniting the sample at 600°C in a muffle furnace to burn off all the organic matter and the crude protein contents by micro Kjeldal method [protein (%) = N x 6.25]. The crude fat was determined using petroleum ether in a soxhlet extraction apparatus and crude fiber content by dilute acid and alkali hydrolysis. Carbohydrate content was calculated by the difference of total contents from 100. Iron, manganese, copper, zinc, sodium and potassium levels were estimated by atomic absorption spectrophotometer (AAS) as described by Raghuramulu *et al.* (2003). All experiments conducted in different drying systems (oven dried, sun-dried and tent dried) were performed in triplicate.

Statistical analysis

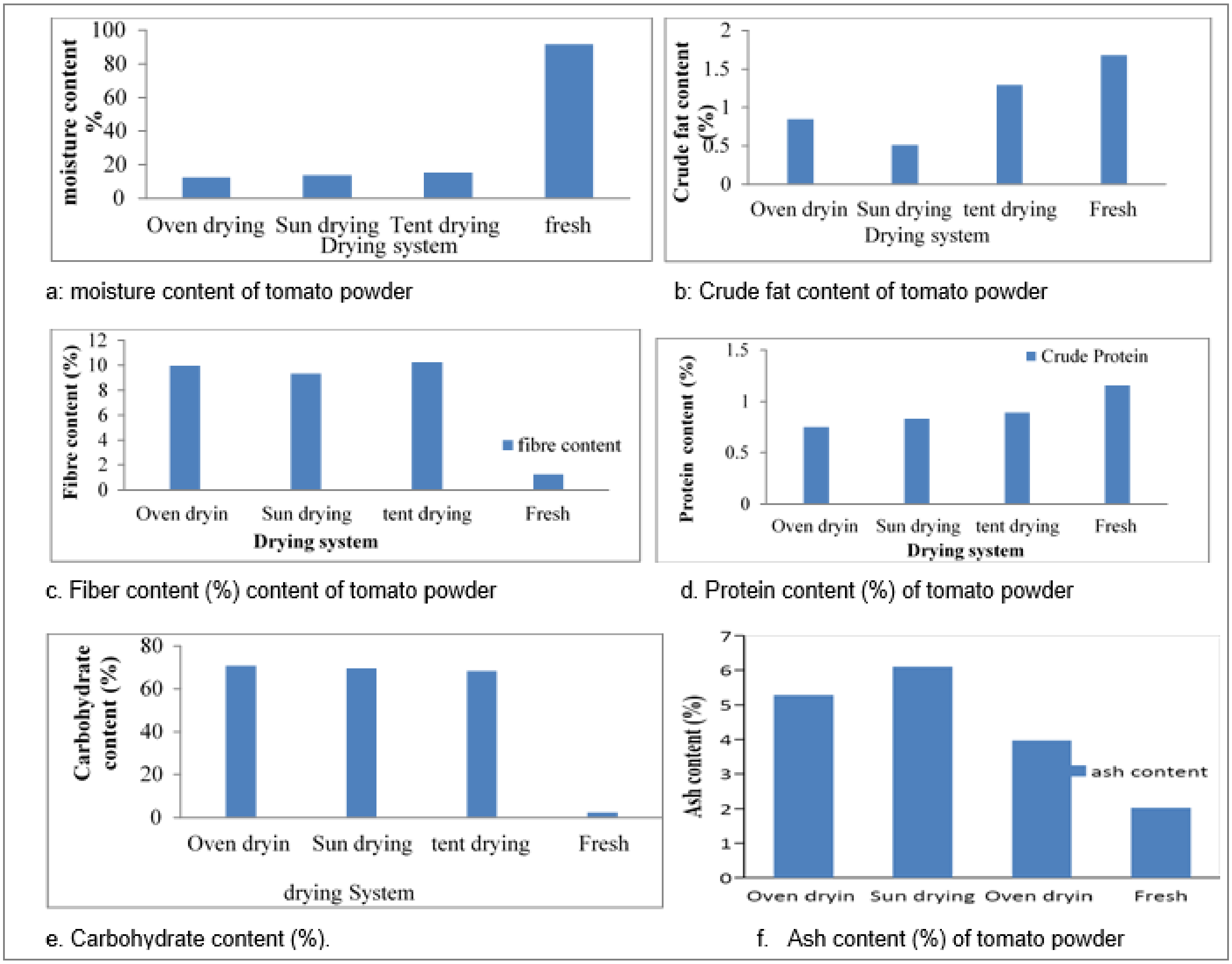
Data were compared on the basis of standard deviation of the mean values. SPSS package (Version 25.0, statistical software) was used for analysis of variance (ANOVA) and Least Significant Difference test (LSD) at a 95% confidence level ($p < 0.05$) to identify significant differences among samples within the evaluated parameters.

RESULTS AND DISCUSSION

Chemical properties of the dried tomatoes powder

Proximate composition

The results of fresh (control) and dried tomatoes powder using different drying system for moisture, ash, crude fiber, protein, fat contents were shown in Figure 1. The moisture content of the fresh tomatoes was 91.62 ±4.327% and statistically different ($p<0.05$) from the moisture content of the dried tomatoes powder. The moisture contents recorded for tomatoes powder dried using oven drying (60°C), open sun drying, and tent drying were (12.51 ± 0.035%), (13.85 ± 0.127%) and (15.24 ± 0.023%) respectively. The oven drying was more effective in removing moisture compared to other drying methods. This was also observed by other researchers (Bankole *et al.*, 2005; Eze and Akubor, 2012). The heat supplied by the convective cabinet is more consistent than the sun which depended on the climate and season at the time of drying (Bankole *et al.*, 2005). Therefore, differences in moisture content were because of different drying methods. The ash content of fresh tomatoes was 2.03 ± 0.148% and lower than the dried samples. Ash content of the dried samples for oven drying was (5.28 ± 0.679%), open sun (6.1 ± 0.474%), and tent drying (3.97 ± 0.038%). Crude protein content for the fresh sample of tomatoes was significantly higher compared to dried samples. Values ranged between (1.18 ± 1.358%) for fresh tomatoes, (0.75 ± 0.00%) oven drying, (0.83 ± 1.216%) sun drying and (0.89%) for tent drying samples. There were significant



a: moisture content of tomato powder

b: Crude fat content of tomato powder

c. Fiber content (%) content of tomato powder

d. Protein content (%) of tomato powder

e. Carbohydrate content (%).

f. Ash content (%) of tomato powder

Figure 1. Proximate composition of tomato powder.

statistical ($p<0.05$) differences between protein content of tent drying of tomatoes and other drying methods. Result of crude fiber was (1.22 ± 1.322%) for the fresh tomatoes and was significantly lower compared to the value for the oven dryer (9.96 ± 0.884%), open sun (9.31 ± 0.247%) and tent drying (10.26 ± 0.113%). The fat content of fresh tomatoes (1.68 ± 0.021%) was significantly higher and different from other forms of drying. Values of (0.85 ± 0.014%), (0.51 ± 0.007%) and (1.29 ± 0.021%) were recorded for oven dry, open sun drying and tent drying. Carbohydrate content of tomatoes powder dried in the oven dryer was gotten as 70.66 ± 0.084% and significantly higher compared to the other forms of drying; open sun (69.4 ± 0.884%), tent dryer (68.35 ± 2.461%), and fresh tomatoes (2.27 ± 0.488%) similar trend was reported by Amoah *et al*. (2020), for drying of ginger. Overall, Table 1 shows the ANOVA results for the measured proximate composition in the samples. As indicated in Table 1, there was no statistically significant difference between the samples (oven, sun and tent drying at $p > 0.05$. This suggests that any of the drying mediums can serve as a good source of drying for tomato powder production. However, since tent drying has the highest nutrients by composition, this study suggests the use of tent drying for production of tomato powder. Further analysis revealed using LSD that, between the carbohydrate and other proximates, there is statistical difference except moisture content.

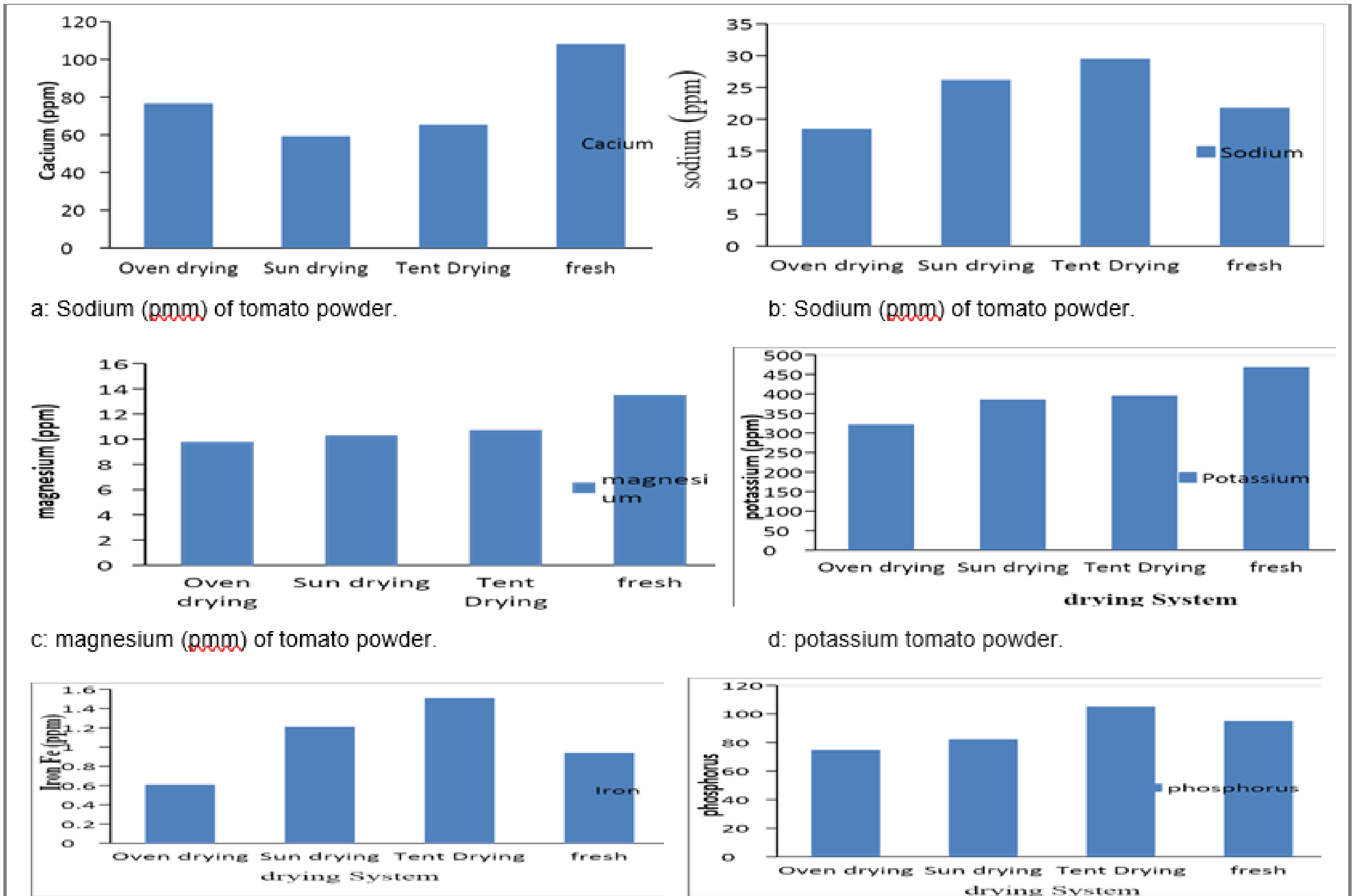
Mineral composition

The mineral contents of fresh and dried samples of tomatoes are given in Figure 2. The mineral compositions of the tent dried tomatoes were higher because of increasing dry matter content. Tent dried tomatoes powdered

Table 1. ANOVA of the proximate compositions of dried tomatoes powder.

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected Model	9186.332[a]	8	1148.292	2.155	.095
Intercept	6667.000	1	6667.000	12.510	.003
Treatments	1.250E-5	3	4.167E-6	.000	1.000
Proximate	9186.332	5	1837.266	3.447	.028
Error	7994.052	15	532.937		
Total	23847.385	24			
Corrected Total	17180.384	23			

R^2 = 0.535 (Adjusted R Squared = 0.287).



a: Sodium (pmm) of tomato powder.

b: Sodium (pmm) of tomato powder.

c: magnesium (pmm) of tomato powder.

d: potassium tomato powder.

e: Iron Fe (ppm) of tomato powder.

f: Phosphorus of tomato powder.

Figure 2. Mineral composition of tomato powder.

had high amounts of Na, Fe and P minerals while Ca, K and Mg content is higher for the fresh sample. The Na (29.55± 3.536 mg/100g), K (395.45± 3.536 mg/100g), Mg (10.73 ± 1.414 mg/100g), Fe (1.51± 0.141 mg/100g) and (105.28 ± 3.536 mg/100g) value determined for tent dried samples is not significantly higher than that of sun dried sample at $p<0.05$ but significantly higher than the value gotten from oven dried.

However, the oven drying method led to high Ca (105.28 ± 0.141 mg/100g) value compared to the value obtained from open sun drying and tent drying systems that are not significantly different from one another. Therefore, the mineral composition of this study is in the same range with the value reported by Rahman and Wan Rosli (2014) for

Table 2. ANOVA of the elemental compositions of dried tomato powder.

Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected model	442888.099[a]	8	55361.012	91.170	0.000
Intercept	236619.389	1	236619.389	389.673	0.000
Sample	3737.405	3	1245.802	2.052	0.150
Minerals	439150.694	5	87830.139	144.642	0.000
Error	9108.385	15	607.226		
Total	688615.873	24			
Corrected total	451996.484	23			

R^2 = 0.980 (Adjusted R Squared = 0.969).

dried maize. Table 2 shows the ANOVA results for the measured elemental compositions of the samples (oven dried, sun dried and tent dried). Findings shown in Table 2, that there was no significant difference between the samples at $p > 0.05$. This suggests that any of the drying systems can serve as a good source for drying tomatoes powdered. In addition, since tent drying had the highest nutrient by composition, this study recommended the use of tent drying and further research should be carried out on the vitamins, microbial content and storability of the tomatoes powdered.

Conclusion

In this research, drying techniques were applied for drying of tomato namely oven drying, tent drying and sun drying, and also effects of these drying methods on nutrient contents of tomato were investigated. By composition, tent drying was found to contain the highest amounts of crude protein (0.89%), crude fiber (10.26 ± 0.113%), and fat content (1.29 ± 0.021%). There were significant statistical ($p<0.05$) differences between protein content of tent drying of tomatoes and other drying methods. It can be concluded that the dried tomatoes powdered samples analyzed are rich and cheap sources of nutrients but its concentration is grossly reduced by drying which is the most common means of preservation employed for results obtained in this study.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

REFERENCE

Adejumo, B. A. (2012). The effect of pretreatment and drying on some vitamin contents of tomato powder. *Annals Food Science and Technology*, *13*(2), 156-160.

Akanbi, C. T., & Oludemi, F. O. (2004). Effect of processing and packaging on the lycopene content of tomato products. *International Journal of Food Properties*, *7*(1), 139-152.

Amoah, R. E., Kalakandan, S., Wireko-Manu, F. D., Oduro, I., Saalia, F. K., & Owusu, E. (2020). The effect of vinegar and drying (Solar and Open Sun) on the microbiological quality of ginger (Zingiber officinale Roscoe) rhizomes. *Food Science & Nutrition*, *8*(11), 6112-6119.

AOAC (2000). Association of Official Analytical Chemists. Official methods of analysis. 17th edition, Washington DC. USA.

Bankole, S. A., Joda, A. O., & Ashidi, J. S. (2005): The use of powder and essential oil of *Cynbopogon citrtus* against mould deterioration and aflatoxin contamination of egusi melon seeds. *Journal of Basic Microbiology, 45*(1), 20-30.

Demiray, E., & Tulek, Y. (2008). Tomatoes dehydration technology and the effect of dehydration on some antioxidant compounds of tomatoes process. *Electronic Journal of Food Technology*, 3, 9-20. (In Turkish).

Eze, J. I., & Akubor, P. I. (2012). Effect of drying methods and storage on the physicochemical properties of okra. *Journal of Food Processing and Technology*, *3*(8), 177.

FAO (2010). *Statistics*. Faostat-Agriculture. Retrieved from http://faostat.fao.org/site/339/default.aspx.

Grabowski, S., Marcotte, M., & Ramaswamy, H. S. (2003). Drying of fruits, vegetables, and spices. Handbook of post harvest technology: Cereals, fruits, vegetables, tea, and spices. New York. Pp. 653-695

Jing, Y., Chen, J. F., Zhao, Y. Y., & Mao, L. C. (2010). Effects of drying processes on the antioxidant properties in sweet potatoes. *Agricultural Sciences in China*, *9*(10), 1522-1529.

Latapi, G., & Barrett, D. M. (2006). Influence of pre-drying treatments on quality and safety of sun-dried tomatoes. Part I: Use of Steam Blanching, Boiling Brine Blanching, and Dips in Salt or Sodium Metabisulfite. *Journal of Food Science*, *71*(1), S24-S31.

Maskan, M. (2001). Drying, shrinkage and rehydration characteristics of kiwifruits during hot air and microwave drying. *Journal of Food Engineering*, *48*(2), 177-182.

Sagar, V. R., & Suresh Kumar, P. (2010). Recent advances in drying and dehydration of fruits and vegetables: A review. *Journal of Food Science and Technology*, *47*, 15-26.

Youssef, K. M., & Mokhtar, S. M. (2014). Effect of drying methods on the antioxidant capacity, color and phytochemicals of Portulaca oleracea L. leaves. *Journal of Nutrition & Food Sciences*, *4*(6), 322.

Tuik (2010). Crop production statistics, vegetable cultivated for their fruit. Turkish Statistical Institute.

Mepba, H. D., Eboh, L., & Banigo, D. E. B. (2007). Effects of processing treatments on the nutritive composition and consumer acceptance of some Nigerian edible leafy vegetables. *African Journal of Food, Agriculture, Nutrition and*

Development, *7*(1), 1-18.

Rahman, N. A., & Wan Rosli, I. W. (2014). Nutritional compositions and antioxidative capacity of the silk obtained from immature and mature corn. *Journal of King Saud University-Science*, *26*(2), 119-127.

Raghuramulu, N., Nair, K. M., & Kalyanasundaram, S. (eds.). (1983). *A manual of laboratory techniques*. National Institute of Nutrition, Indian Council of Medical Research, Hyderabad. Pp. 319-320.