

DEVELOPMENT OF NUTRITIONAL POWDERED SEASONING USING SELECTED PHILIPPINE VEGETABLE

Lea May S. Araneta^{1,b}, Denille G. Manalang¹, and Christine O. Cruz^{2,a}

¹Bachelor of Science in Nutrition and Dietetics, College of Business Administration and Accountancy

²Faculty Member, Food Technology Program, College of Business Administration and Accountancy

^achristine.cruz@letran.edu.ph, ^baranetalea452@gmail.com

ABSTRACT

Micronutrient deficiency is a widespread issue in all ages among developing countries. In order to address this, great interest in supplements from blends of natural herbs and spices has been given because of the health benefits they confer. With this, the study aimed to develop a powdered nutrient supplement out of locally available vegetables in the market and to identify presence of nutrients after undergoing convective drying and cryogenic grinding. The fresh vegetables have undergone drying and grinding to obtain a powdered vegetable. The samples were then analyzed for proximate properties which consist of moisture content, ash, fat, carbohydrates, and protein content. Mineral analysis (sodium, iron, and calcium) was also conducted. Moreover, the total plate count was observed for biological activity. It was found out that the powdered vegetable is high in beta-carotene with traces of minerals like calcium and iron. The sodium content was low compared to the commercially available supplements. From this study, we can conclude that the powdered vegetable supplement has a potential in substituting the commercially available seasonings in the market which has more sodium with less vitamin and mineral content.

Keyword: Supplement, Proximate Composition, Mineral Content, Nutritional Value, Micronutrient Deficiency Supplement, Proximate Composition, Mineral Content, Nutritional Value, Micronutrient Deficiency

INTRODUCTION

The wide-ranging prevalence of hidden hunger or commonly known as micronutrient deficiency is a significant determinant of poor human health in many emerging countries of Asia including the Philippines. The most applicable and maintainable way to mitigate micronutrient deficiency is incorporating micronutrient-rich foods like vegetables, fruits and livestock products into diets (Hassan, 2015). The Food and Nutrition Research Institute-Department of Science and Technology (FNRI-DOST) conducted the 7th National Nutrition Survey (2007) and reported a decreasing trend in Vitamin A deficiency (VAD) prevalence among preschool children 6mos – 5 yrs old (15.2%), pregnant (9.5%) and lactating women (6.4%). However, VAD is still a significant problem of public health based on World Health Organization (WHO) but has declined from severe in 2003 to moderate in 2008 among preschool children, and to mild among pregnant and lactating women. Moreover, researches showed that deficiency in Vitamin A is one of the main reasons of blindness among children (WHO, 2014). As the deficiency develops, the individual may experience diarrhea, respiratory infection and xerophthalmia (Humphrey, West & Somer, 2010).

Another deficiency that was mentioned is the lack of Iron intake that leads to Iron deficiency wherein rates in all population groups have been slowly declining over the past 2 to 3 NNSs. Infants 6 months to 1 year of age still have the highest anemia rates (39.4%) among population groups, though this figure is already a marked

improvement over the 2003 (66.2%) and 2008 (55.7%) rates, supplementation is strongly encouraged. Even rates among pregnant (25.2%) and lactating women (16.6%) have been drastically reduced from 2008 levels of 42.5% and 31.6% respectively (NNS, 2013).

On the other hand, a study conducted by National Nutrition and Health Survey (NNHeS) in 2003, it was stated that 26% of women and 11.4% of men aged between 60–69 years are considered at high risk for calcium deficiency which causes osteoporosis. This is also true for 79.1% of women and 62.2% of men aged over 70 years. From these numbers, it has been projected that the number of Filipinos at high risk for osteoporosis will reach 4 million by 2020 and 10.2 million by 2050.

To give perspective on more recent data, the Osteoporosis Society of the Philippines Foundation Inc. (OSPFI), found that the prevalence of low bone mass (T-score < -2.0) in Filipino women aged over 50 years was 65.2% and 68.8% in men. Using the Osteoporosis Self-Assessment Tool for Asians (OSTA), the prevalence of osteoporosis was estimated and found to be an intermediate risk in 45.9% of women and in 43.4% of men. This translates to millions of individuals in the Philippines are at risk of different nutrient deficiency.

Micronutrient deficiencies can cause inter-generational consequences. The level of health care and nutrition that women receive before and during pregnancy, at childbirth and immediately post-partum has significant bearing on the survival, growth and

development of their fetus and newborn. Undernourished babies tend to grow into undernourished adolescents. When undernourished adolescents become pregnant, they in turn, may give birth to low-birth weight infants with greater risk of multiple micronutrient deficiencies such as iron deficiency anemia, vitamin A deficiency and hypocalcemia (National Nutrition Survey, 2013). Iron deficiency remains a major cause of anemia among infants and children (Lai & Yang, 2017). The deficiency affects the learning capacity, movement disorders as well as language disorder of an individual as reported in the study of Miyasaki, Hassan, Lang & Voon in 2012. Great attention was also given to the prevailing calcium deficiency that is experienced by both men and women around the country. Due to the lack of calcium supply in the diet, individuals experience weakening of the bones, decrease bone mass and loss of teeth (FNRI, 2012).

To address these issues, the food industry is seeking new method to supplement these vitamins and minerals. Natural seasonings like dried herbs alternatives are more valued than chemical preservatives and it also enable the combination of intriguing nutrients (Lomillo, San Jose & Garcia, 2017). As a result, there is an increasing strong desire for natural and nature-derived supplements because of the health benefits they confer. The combination of herbs, spices, and seafood was used to develop so that it can be used as replacement for commercially produced supplements (Badejo, 2015). Enhancement of nutrients using blends of natural herbs and spices is a preferred approach to reduce salt as it results in a clean and more nutritious product, avoiding inclusion and declaration of chemical compounds (Ghawi, Rowland & Methven, 2014). These natural supplements are best produced when the nutrients are maintained through the use of drying and grinding which are said to aid in the preservation of nutrients as the vegetable undergo the process (Saxna, Rathore & Barnwal, 2013).

Drying is one of the most established, normal and different food preparation techniques. It is an elaborative process including synchronous heat and mass exchange requiring exact process control (Mujumdar & Passos, 2000 excerpt from Karam, Zimmera & Djantuo, 2016). Drying a wet material suggests vanishing of both free and approximately bound water from inside the strong material into the air. The dormant warmth of vaporization might be provided by convection, conduction and radiation or volumetrically by setting the wet material in microwave or radiofrequency electromagnetic fields (Mujumdar, 2007 excerpt from Karam *et al.*, 2016). Drying is energy concentrated process representing 10-25% of the aggregate energy utilized as a part of the food manufacturing process around the world (Strumillo & Adamiec, 1996 excerpt from Karam *et al.*, 2016). Foods grown from the ground are normally dried to broaden the shelf life, upgrade stockpiling steadiness, limit bundling necessities and decrease transport weight (Ahmed, 2011). Traditional drying, additionally alluded as hot-air (HAD) or convective drying (CD) is the most practical and broadly embraced system in the food

business, despite the fact that requiring long drying times and high air temperatures. In air drying, the warmed air (of low relative humidity) meets the surface of the wet material that moves warm into the solid by conduction. The fluid relocates then onto the material surface and is transported away via air convection. Transport of dampness inside the solid food happens by fluid or vapor dissemination, surface dispersion, hydrostatic weight contrasts and mixes of these (Ahmed, 2011). HAD happens in two phases, each described by an alternate drying rate. In the beginning time, free water moves to the surface and is effectively evacuated by vaporization. At that point, as the drying advances, drying ends up noticeably difficult (the fluid stage contained in solid materials turns out to be thicker) and the drying rate decays (it sets aside more opportunity for the internal moisture to move to the surface) (Nijhuis *et al.*, 1998; Tsamiet *et al.*, 1998; Ratti, 2001; Askari *et al.*, 2009; Argyropoulos *et al.*, 2011; Horszwald *et al.*, 2013). Normally, around 66% of the drying time might be spent expelling the last 33% of the moisture content, for the most part comparing to inexact bound water molecules (Andres, Bilbao & Fito, 2004). In any case, it is vital to point up that on account of some green leafy vegetables, for example, coriander leaves, mint leaves and spinach, moisture evaporation is exceptionally fast and finished at about an hour or two (Ahmed, 2011).

Conventional grinding procedure is another old known and complex process generally utilized as a part of the food business. It is a procedure of size reduction of solid particles subjected to mechanical forces wherein the crack happens inside the failure of inward atomic forces with respect to outside forces. Balasubramanian, Risikat & Sururah (2016) have even detailed an increase in volatile oils and flavor quality (up to two-fold) in ground vegetable flavors, for example, coriander, garlic, celery and onion.

Garlic (*Allium sativum* L.) belongs to the family of *Liliaceae*. Its leaves accumulations (bulb), which can be isolated into cloves, are utilized for culinary and medicinal purposes. It has a trademark pungent and hot flavor (Kasuga *et al.*, 2001 extract in Memudo, Akinrinade & Ogundele, 2015). Garlic is comprised of the essential bioactive parts, for example, allicin (the dynamic compound in charge of its hot sensation), ajoene, proteins, water, vitamin B, minerals and flavonoids (Macpherson *et al.*, 2005 portion in Memudo, Akinrinade & Ogundele, 2015). United States Department of Agriculture Nutrient Database (2015) states that 100g of raw garlic contains starches, dietary fiber, fat, protein, β -carotene, thiamin (Vitamin B1), riboflavin (Vitamin B2), niacin (Vitamin B3), pantothenic corrosive (Vitamin B5), adermin (Vitamin B6), folate (Vitamin B9), vitamin C, calcium, press, magnesium, phosphorus, potassium, sodium, zinc, manganese and selenium.

Bell pepper or *Capsicum annum* (L.), an individual from *Solanaceae* family, is viewed as a standout amongst the most famous and nutritious vegetable. It is rich in supplements as well as included as a characteristic colorant in food arrangements. It has a great mix of sweetness and tartness with a crunchy surface. Bell

peppers are rich sources of vitamins, significantly more so than tomatoes, particularly vitamins A, B6, and C, calcium, and folic corrosive (Jadon, Shah, Gour & Sharmac, 2016).

Celery from the group of *Apium graveolens* L. *Umbelliferae*, is a biennial plant grown in Egypt and in East Asian nations. The plant is utilized as foods, medicine, and natural flavoring for seasoning and smell. The plants are esteemed for their flavor, nourishing components, and therapeutic applications (Macpherson, Geierstanger, Viswanath, Bandell, Eid, Hwang *et al.*, 2005 excerpt in Helaly, Back, Mady, Eldekashy & Craker 2015). The celery plant is perceived for the substance of vitamins A, B1, B9, C, E, and K, notwithstanding the minerals Calcium, Manganese, Magnesium, Phosphorous, Iron, and Zinc (Domagaa-Swiatkiewicz and Gasto, 2012).

Carrot or *Daucuscarota* L. is one of potential plant product which has chance to be extended after the expanding of local and export demand. Carrots contain nutrients that are required by the body, particularly vitamins and minerals. Carrots have beta-carotene as a vital chemical compound to form vitamin A or provitamin A (Gao, Yu & Lui, 2017). Carrot is one of the vital root vegetables rich in bioactive compounds like carotenoids and dietary fibers with calculable levels of a few other useful parts having huge health advancing properties. The utilization of carrot and its items is expanding relentlessly because of its acknowledgment as a critical source of regular cancer prevention agents having anticancer action. Aside from carrot being traditionally utilized as a part of serving of mixed greens and arrangement of curries in India, these could exchange into nutritiously rich prepared items like juice, condensed, dried powder, canned, preserve, candy, pickle, and gazrailla (Sharma, Raghu, Lu & Sheen, 2014).

The use of vegetables to enhance nutrient intake is an area of research that needs further attention. This may help individuals especially adults reach their daily nutrient recommendation in a way that seems effortless and enjoyable. This study will be carried out to develop a nutritional powdered seasoning out of locally available vegetables in the market to be used as alternative healthy seasoning and to identify the presence of nutrients after undergoing convective drying and conventional grinding. The scope of this study is to develop a natural nutrient supplement from bell pepper, carrots, celery and garlic which are known to have great potential as seasonings that can be incorporated to food products. The study limits only to the development of the natural powdered seasoning and identification of vitamin A, calcium and Iron after the process of drying and grinding.

METHOD

Plant Material

Collection and Identification

The study used *Allium sativum* (Garlic), *Apium graveolens* (Celery), *Capsicum annuum* (Bell pepper), and *Daucuscarota* subsp. *Sativus* (Carrots). The vegetables were gathered at an open market in Barangay Marulas, Valenzuela City. The specific vegetables namely: garlic, celery, bell pepper and carrots are highly nourishing because they are sold fresh in the public market. The vegetables were selected based on their availability and nutrient content. The vegetables were brought to the Bureau of Plant Industry, Manila Philippines for authentication.

Preparation of Samples

The vegetables were washed thoroughly in warm water to remove unwanted substances, then the washed vegetables were sliced one inch and chopped mince for the garlic to allow greater surface area for drying. The fresh vegetables used were garlic, bell pepper, carrots and celery which weighed 1.5 kg, 4 kg, 4 kg and 4.5 kg respectively.

The amount of garlic which is less than the weight of other ingredients was due to its strong aroma. The 4 kg of bell pepper was used because of its sweet taste while the 4 kg of carrots because of its unique composition between sweet, fruity and stronger flavor. Whereas for celery, more amounts were used due to its higher moisture content which leads to loss of weight during dehydration process. The ratio of vegetables was selected according to different characteristics like aroma, taste, and appearance for the vegetables not to overpower with the other (Badejo, 2015).

Drying of Vegetables

Vegetable materials were dehydrated by convective drying machine at different temperatures. Celery, bell pepper, and carrots were dried starting at 55°C to 65°C for 6-8 hours. On the other hand, garlic has the higher drying temperature which started from 65°C to 75°C for 6-8 hours. This method was patterned according to the standard method used by the Department of Science and Technology.

Grinding of Dried Vegetables

After drying, several experimentations were conducted to obtain an exact proportion. This helped in obtaining a ratio of 400g of garlic, 300g of carrots, 200g of bell pepper and 100g of celery. After which, the vegetables undergone conventional grinding at the Department of Science and Technology.

Table 1: Different Formulations of the Powdered Vegetable Seasoning

	Sample A	Sample B	Sample C
Garlic	400g	300g	200g
Celery	100g	200g	300g
Bell Pepper	200g	400g	100g
Carrots	300g	100g	400g

Chemical Test

Proximate Analysis

The 300g powdered vegetable mixture from Sample C were brought to the First Analytical Services and Technical Cooperative Laboratory, Cubao, Quezon City to identify the moisture, fat, ash, carbohydrates and protein according to the Official Method of Analysis of AOAC International 19th Edition 2012. Mixture was taken from Sample C since it has the most appropriate characteristics when it comes to aroma, texture and color.

Vitamin and Mineral Analysis

The identification of beta carotene, sodium, iron and calcium were analyzed by the First Analytical Services and Technical Cooperative Laboratory, Cubao, Quezon City using High Performance Liquid Chromatography, Flame AES and Atomic Absorption Spectrophotometry respectively.

Microbiological Test

The 100g powdered vegetable samples from Sample C were brought to the First Analytical Services and Technical Cooperative Laboratory, Cubao, Quezon City to identify the total plate count using the pour plate method (Sanders, 2015).

RESULTS AND ANALYSIS

The nutritional components of the different plant type make them the primary compositions of the beneficial dietary intake for the wellness and development of an individual. It is of great importance to harness insight on the types of substances that supply energy and promote food digestibility that is present in the powdered vegetable supplements before efficient formulation and production of market quality diets could be successfully achieved. Therefore, proximate parameters were determined to ascertain the dietary usefulness (Ajani, *et al.*, 2016) and the result was as shown in Table 1; the moisture content (6.28g/100g), carbohydrate (77.45g/100g), fat (2.94g/100g), protein (34.94g/100g), beta carotene (37,462IU/100g), sodium (856mg/100g), iron (4.75mg/100g), calcium (172mg/100g) and ash content (7.74g/100g). The potential of the powdered vegetable supplement as food

enhancer and particularly as alternative natural supplement is exemplified by the proximate composition and presence of a few bacteria in the analyzed dried vegetable sample. The high amount of beta carotene and traces of calcium and iron as well as the low sodium content indicate the potentialities of the powdered vegetable supplement as probable substitute for high sodium, low nutrient content, and commercially-available food supplements. Table 2 shows the comparison of the nutrient content of the powdered vegetable supplement and the commercially available supplement. It revealed that there is a high difference when it comes to sodium content. Also, the commercially available supplements lack vitamins and minerals which is present in the powdered vegetables supplement.

Table 2: The Proximate Composition of Nutritional Powdered Seasoning

Parameters	Unit	Test Method	Results
Moisture	g/100g	Vacuum Oven Drying	6.28
Ash	g/100g	Ignition	7.74
Fat	g/100g	Acid Hydrolysis-Soxhlet Extraction	2.94
Carbohydrates	g/100g	by Computation	77.45
Protein	g/100g	Kjeldahl	5.59

Table 3: The Mineral Composition of Nutritional Powdered Seasoning

Parameters	Unit	Test Method	Results
Beta Carotene	IU/100g	High Performance Liquid Chromatography	37, 462
Sodium	mg/100g	Flame AES	856
Iron	mg/100g	Atomic Absorption Spectrophotometry	4.75
Calcium	mg/100g	Atomic Absorption Spectrophotometry	172

Table 4: Comparison of Powdered Vegetable Seasoning and Commercially Available Seasonings

Nutrients	PDRI		Powdered Vegetable Supplement	Magic Sarap	AjiGinisa
	Female	Male			
Sodium	2,300mg	2,300mg	85.6mg/10g	2,350mg/10g	1,540mg/10g
Calcium	750mg	750mg	17.2mg/10g	0%	0%
Iron	12mg	10mg	0.475mg/10g	0%	0%
Vitamin A	700IU	600IU	374.62IU/10g	0%	0%

The total plate count of the nutritional powdered seasoning was also evaluated. The result is shown in Table 3. There was a highly significant difference in bacterial count of the nutritional powdered seasoning when compared to the other seasonings like cold chili powders which showed bacterial population within the range of $33.3\text{--}36 \times 10^5\text{cfu/g}$ (Akhigbemidu, Musa, & Kuforiji, 2015). The component of garlic also helped in lowering the growth of bacteria, pathogens, especially bacteria and fungi where it is considered to be an antimicrobial (Memudu, Akinrinade, Ogundele 2015; 1998 excerpt from Saleh, N., *et al.*, 2015), an antioxidant and an antihypertensive agent according to Konjufca *et al.*, 1997 excerpt from Saleh, N., *et al.*, 2015. In addition, according to the Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market, the standard limit for raw, ready-to-eat food commodities such as salad vegetables, total plate count is likely to be much higher, between 10^6 and 10^8cfu/g , thus it may limit the shelf life as spoilage may occur rapidly and will usually be noticeable. The standard total plate count value can be similarly compared to a more rigorous heat process such as grilling, roasting or baking will result in counts below 10^3cfu/g .

Table 5: The Total Plate Count of the Powdered Vegetable Supplement

Parameter	Test Method	Result	Critical Value
Total Plate Count, CFU/g	Pour Plate	5.1×10^3	$10^6 - 10^8$

CONCLUSION

The proximate analysis conducted on the powdered vegetable supplement showed a positive result with beta-carotene showing a high content of 37, 462 IU/100g and sodium showed a lower amount of 856mg/100g compared to the commercially available supplements where two existing supplements has 470mg/2g and 280mg/1.8g of sodium. There are also traces of minerals like calcium and iron that can add to the nutrients already present in the food. In conclusion, the powdered vegetable supplement contains vitamins and minerals that can be good for supplementation to achieve the daily recommended intake which cannot be found in the diet alone. On the other hand, bacterial count revealed that it has low colony-forming unit because of low moisture content of 6.28 much like to 10.3 result of wheat flour, whole grain. Moisture is an excellent factor in the preservation of some products like dehydrated vegetables that may also affects stability of the product. (Bradley, 2010) In addition, the data obtained from the proximate analyses and bacterial test clearly exemplify the nutritional potentials of this powdered vegetable supplement as probable substitute particularly for commercial supplements.

From this study, the researchers can conclude that the powdered vegetable supplement has a potential in substituting the commercially available supplements and seasonings in the market which has more sodium with less vitamin and mineral content.

RECOMMENDATION

Nutrition facts should be done to present the content of nutrients present in the sample. Powdered nutrient supplement should undergo further tests with different ratios of vegetables and different parameters. The researchers also recommend the different combinations of vegetables with high sources of calcium and iron to supply more amounts in the diet. Additionally, there have been further studies about the potential of the combination of garlic, carrots, bell pepper and celery to become a natural seasoning. Moreover, general acceptability test is also recommended to know if the product will gain positive response from consumers as an alternative seasoning.

REFERENCES

- Ahmed, J., (2011). Drying of vegetables: principles and dryer design. In: Sinha, N.K., Hui, Y.H. Ozgul Evranuz, E., Siddiq, M., J.Ahmed (Eds.), Handbook of Vegetables and Vegetable Processing. Wiley Blackwell publishing, pp. 279-298.
- Ajani, O.O., Owocye, T.F., Olaschinde, G.I., Audu, O.Y., Owolabi, F.E., Akinlabi, D.K., and EdoborOsoh, A., Am. J. Food Tech., 11(6), 253 (2016). Characterization, Proximate Composition and Evaluation of Antimicrobial Activity of Seed Oil of *Bauhinia tomentosa*
- Akhigbemidu, W., Musa, A., &Kuforiji, O. (2015). Assessment of the microbial qualities of noodles and the accompanying seasonings.
- Albar, B.N., Bayduha, B.B (2016). Enrichment of Noodles with Soy Flour and Carrot Powder, 74- 81
- Andres, A., Bilbao, C., Fito, P., (2004). Drying kinetics of apple cylinders under combined hot air- microwave dehydration. J. Food Eng. 63 (1), 71-78.
- Argyropoulos, D., Heindl, A., Muller, J., (2011). Assessment of convection, hot-air combined with microwave-vacuum and freeze-drying methods for mushrooms with regard to product quality. Int. Journal. Food Sci. Technol. 46 (2), 333-342.
- Askari, G.R., Emam-Djomeh, Z., Mousavi, S.M., (2009). An investigation of the effects of drying methods and conditions on drying characteristics and quality attributes of agricultural products during hot air and hot air/microwave-assisted dehydration. Dry. Technol. 27 (7e8), 831-841.

- Badejo, A., (2015). Nutrient Composition and Antioxidative Potential of Seasonings Formulated from Herbs, Spices, and Seafood, *Journal of Culinary Science and Technology*, 14(3), 222-233
- Balasubramanian, H.A., Risikat, A.N. & Sururah, A.R. (2016). Food: Its preservatives, additives and applications, *Journal of Chemical and Biochemical Sciences*, 36-47
- Bradley, R. (2010). Moisture and Total Solids Analysis, 87-104
- Ehiri, R.C., & Njoku, C.N (2014). Proximate Nutritional Analysis and Heavy Metal Composition of Dried Moringa Oleifera Leaves from Oshiri Onicha L.G.A, Ebonyi State, Nigeria, *Journal Of Environmental Science, Toxicology And Food Technology*, 8(1), 57-62
- Food and Nutrition Research Institute-Department of Science and Technology (2013). 8th National Nutrition Survey.
- Food and Nutrition Research Institute-Department of Science and Technology (2008). 7th National Nutrition Survey.
- Gao B, Yu L, Liu J. (2017). Home-based preparation approaches altered the availability of health beneficial components from carrot and blueberry. *Food Sci Nutr*, 5:793–804.
- Ghawi, S.K., Rowland, I., & Methven, L. (2014). Enhancing consumer liking of low salt tomato soup over repeated exposure by herb and spice seasonings, 81, 20-29.
- Guidelines for Assessing the Microbiological Safety of Ready-to-Eat Foods Placed on the Market (2014)
- Guo, X.D., Wu, C.S., Ma, Y.J., Parry, J., Xu, Y.Y., Liu, H., Wang, M., (2012). Comparison of milling fractions of tartary buckwheat for their phenolics and antioxidant properties. *Food Res. Int.* 49 (1), 53-59.
- Hassan, N.N.A. (2015). The prevalence of iron deficiency anemia in a Saudi University female students, *Journal of Microscopy and Ultrastructure*, 3(1), 25-28.
- Helaly, A.A., Jun Pill Back, Emad Mady, M.H.Z. Eldekashy, & Lyle Craker. (2015). Phytochemical Analysis of Some Celery Accessions, *Journal of Medicinally Active Plants* 4, (1):1-7
- Horszwald, A., Julien, H., Andlauer, W., (2013). Characterization of Aronia powders obtained by different drying processes. *Food Chem.* 141 (3), 2858-2863.
- Humphrey, J.H., West, K.P Jr, Sommer A. (2012). Vitamin A deficiency and attributable mortality among under-5-year-olds, 70(2), 225-32.
- Jadon, K.S., Shah, R., Gour, H.N., and Sharmac, P. (2016). Management of blight of bell pepper (*Capsicum annuum* var. *grossum*) caused by *Drechslera bicolor*, *Brazilian Journal of Microbiology*, 47(4): 1020–1029.
- Kasuga S, Uda N, Kyo E, Ushijima M, Morihara N, Itakura Y. (2001). Pharmacologic activities of aged garlic extract in comparison with other garlic preparations. *Journal of Nutrition*; 131(3s): 1080S-1084S.
- Karam, M.C., Zimmera, J.P.D., Elie Baudelaire Dantou, E.B., (2016). Effects of drying and grinding in production of fruit and vegetable powders: A review, 32-49
- Konjufca, V.K., Bottje, W.G., Bersi, T.K., & Erf G.F. (2013). Antioxidant and antihypertensive activity of extract from *Thymus serpyllum* L. in experimental hypertension.
- Lai, F.P., Yang Y.J. (2017). The prevalence and characteristics of cow's milk protein allergy in infants and young children with iron deficiency anemia. 1-5.
- Lomillo, G.J., San Jose, M.G., Garcia, R. (2017). A new seasoning with potential effect against foodborne pathogens, *Food Science and Technology*, 84, 338-343.
- Lopez, M.L (2013). Relationships between the instrumental and sensory characteristics of four peach and nectarine cultivars stored under air and CA atmospheres, 75, 58-67
- Macpherson IJ, Geierstanger BH, Viswanath V, Bandell M, Eid SR, Hwang S. (2005). The pungency of garlic: activation of TRPA1 and TRPV1 in response to allicin. *Curr Biol*; 15(10): 929-934.
- Memudu, A.E., Akinrinade, I.D., Ogundele, O.M. (2015). Retention of testicular integrity and testosterone levels upon ingestion of garlic cloves (*Allium sativum*) in the Sprague-
- Dawley rat, *Asian Pacific Journal of Tropical Biomedicine*, 5(4), 319-323
- Miyasaki, J.M., Hassan, K.A., Lang, A.E., & Voon, V., (2012). Punding prevalence in Parkinson's disease, *Official Journal of the International Parkinson and Movement Disorder Society*, 22(8), 1179-1181
- Mongi, R.J., Ndabikunze, B., Chove, B., & Wicklund, T., (2013). Descriptive Sensory Analysis, Consumer Liking and Preference Mapping for Solar Dried Mango cv Dodo, *Food Science and Quality Management*, 16-23
- Mubarik, A., Samson C.S. & Tsou. (2013). Combating micronutrient deficiencies through vegetables—a neglected food frontier in Asia, 22(1), 17-38

- Mujumdar, A., Passos, M.L., (2000). Developments in Drying. Bangkok Kasetsart University Press.
- Mujumdar, A.S., 2007. An overview of innovation in industrial drying: current status and R&D needs. In: Kowalski, S.J. (Ed.), Drying of Porous Materials. Springer Publishing, pp. 318.
- Murthy, C.T., Bhattacharya, S., (2008). Cryogenic grinding of black pepper. J. Food Eng. 85 (1), 18-28.
- Nijhuis, H.H., Torringa, H.M., Muresan, S., Yuksel, D., Leguijt, C., Klock, W., (1998). Approaches to improving the quality of dried fruit and vegetables. Trends Food Sci. Technol. 9 (1), 13-20.
- Official Method of Analysis of AOAC International 19th Edition 2012. Pesck, C.A., Wilson, L.A., Hammond, E.G., (1985). Spice quality: effect of cryogenic and ambient grinding on volatiles. J. Food Sci. 50 (3), 599-601.
- Ratti, C., (2001). Hot air and freeze-drying of high-value foods: a review. Journal of Food Eng. 49 (4), 311e319.
- Saleh, N., Fady, R., &Toutou, M. (2015). Evaluation of garlic and onion powder as phyto additives in the diet of sea bass (*Dicentrarcuslabrax*), 41(2), 211-217
- Sanders, E.R., (2015). Aseptic Laboratory Techniques: Plating Methods. Journal of Visualized Experiments. 6 (1), 20-25.
- Saxna, S.N., Rathore, S.S., Barnwal, P. (2013).Cryogenic grinding: A physical technique to retain volatile content in natural products. International Journal of Modern Physics: Conference Series, 22, 589-592
- Sharma, B.S., Raghu, R., Lu, K-H., & Sheen, L-Y. (2014). Recent Research Progress on Garlic (dàsuàn) as a Potential Anticarcinogenic Agent Against Major Digestive Cancers, Journal of Traditional and Complementary Medicines, 2(3), 192-201
- Shekhar, C., (2013). Hidden Hunger: Addressing Micronutrient Deficiencies Using Improved Crop Varieties, Journal of Chemistry and Biology, 20 (11), 1305-1306
- Strumillo, C., Adamiec, J., (1996). Energy and quality aspects of food drying. Dry. Technol. 14 (2), 423-448.
- Tang, Y. P., Linda, B. L. & Franz, L. W. (2013). Proximate analysis of *Artocarpusodoratissimus* (Tarap) in Brunei Darussalam, International Food Research Journal, 20(1), 409-415 Offor, I.F.
- Tsami, E., Krokida, M.K., Drouzas, A.E., (1998). Effect of drying method on the sorption characteristics of model fruit powders. J. Food Eng. 38 (4), 381-392.
- United States Department of Agriculture Nutrient Database (2015)
- World Health Organization (2014)
- Wu, L., Orikasa, T., Ogawa, Y., Tagawa, A., (2007). Vacuum drying characteristics of eggplants. Journal of Food Eng. 83 (3), 422-429.