Journal of Applied Biosciences 48: 3322– 3330

ISSN 1997–5902

Effect of fertilizer types on nutritional quality of two cabbage varieties before and after storage

Ojetayo A. E, J.O. Olaniyi, W. B. Akanbi and T. I.Olabiyi
Department of Agronomy, Ladoke Akintola University of Technology, P.M.B 4000, Ogbomoso, Nigeria.

*Correspondent author, E mail: Olaniyikunle2005@yahoo.com
Originally Submitted on 28th June 2011. Published online at www.m.elewa.org on December 29, 2011.

ABSTRACT
The effect of fertilizer types on the nutritional composition of two cabbage varieties before and after storage was determined. The treatments involved 8 fertilizer types (NPK, neem, alesinloye organomineral, sunshine organomineral, sunshine organic, cassava peel compost, alesinloye organic and pacesetter organomineral fertilizers) applied at 60kg/ha and a control, applied to two cabbage varieties (Copenhagen market and F1 milor). The treatments were laid out in randomized complete block design fitted into split plot with variety as the main plot factor and fertilizer types as sub plot factor, replicated three times. Data were collected on the number of rotted leaves, degree of rottenness and nutritional composition of cabbage before and after storage. The nutritional composition of cabbage head before and after storage was significantly ($p = 0.05$) influenced by the applied fertilizers and variety. Higher K and vitamin C contents were determined in Copenhagen market while F1 milor recorded higher P, Ca and crude protein composition before storage. The two varieties had similar average value of Mg content in the cabbage head before storage. Organomineral fertilizers resulted into the highest phosphorus, pottassium and crude protein contents of cabbage head before storage while NPK treatments resulted in more vitamin C content. Although there were inconsistencies in the nutritional compositions of cabbage after storage, F1 milor retained more minerals compared to Copenhagen. Organomineral fertilizers (Pacesetter > Sunshine > Alesinloye) compared well with NPK (15:15:15) and enhanced optimum nutritional compositions of cabbage varieties before and after storage. Neem fertilizer improved the storability of cabbage varieties. Despite the pre and post- harvest constraints encountered with the cabbage varieties used, F1 milor had better nutritional values than Copenhagen market with or without fertilizer, therefore can be recommended as the better variety for Ogbomoso, South West, Nigeria.
Key word: *Brassica oleracea* L, nutritional values, organomineral, storage losses, minerals, organic

INTRODUCTION
The cabbage (*Brassica oleracea* L.) is one of the oldest vegetables grown. The Food and Agricultural Organization (FAO, 1988) has identified cabbage as one of the top twenty vegetables and an important source of food globally. Cabbage is also reported (Fowke *et al.,* 2003) to be an excellent source of vitamin C and K. A 100 g edible portion of cabbage contains 1.8 g protein, 0.1g fat, 4.6 g carbohydrate, 0.6 g mineral, 29 mg Ca, 0.8 mg Fe and 14.1 mg Na. Moreover, it is a rich source of vitamin A and C (FAO, 2000). Consumption of cruciferous

vegetables, such as cabbage, is known to reduce the risk of several cancers, especially lung, colon, breast, ovarian and bladder cancer. Research also reveals that crucifers provide significant cardiovascular benefits (Beecher, 1994). Hundreds of cultivars of headed cabbage are grown worldwide. In the market gardens of tropical regions early maturing compact round or flat - headed F1 hybrids of white headed cabbage are increasingly replacing the open pollinated cultivars such as 'fresco', 'gloria', and 'milor'. (Muhammed *et al*., 2007). Optimally, cabbage requires 60 - 85 kg N/ha; 60 - 80 kg P_2O_5/ha and 30 - 90 kg K_2O/ha (Shika and Doug, 2001). Bhardwaj *et al* (2000) and Muhammed *et al*. (2007) reported higher yield and nutritional quality in cabbage at the rate of 60 kg N/ha from organic fertilizer sources (neem) and NPK. Cabbages stored at 0°C temperature and at 90 – 95 % relative humidity will last for 4 - 6 months depending on the cultivar. It is easier to maintain a temperature of 5 – 8 °C and relative humidity of 90 - 95 % under refrigerated storage (OMAF, 2010). According to Doug (2005), Jim and Tony (2006) and OMAF (2008) cabbage can be stored between 3 - 6 months within a modified environment (controlled atmospheric condition), which suppresses metabolic activities. Nutritional quality aspects include the presence of beneficial and harmful ingredients, taste, fragrance, freshness and shelf-life (Kopke, 2005) as well as the risk of toxic pathogens (Sagoo *et al.,*2001). For cabbage, the marketable and nutritional quality depends heavily on the agronomic practices. Fast release of nitrogen (N) from fertilizers or a surplus of N can lead to an increase in nitrate content of plant tissues (Vogtmann *et al.,* 1984; Sorenson *et al.,* 1996). Many reports indicate there is only limited effect of fertilizer especially N on storage losses (Slangen *et al*., 1990; Freyman *et al*., 1991). The productivity and quality of vegetable crops especially cabbage depends on the growing conditions, fertilizer application and storage methods. Despite many investigations in area of nutrition and knowledge about how fertilizers influence the nutritional composition and shelf – life of cabbage, there is need to investigate further on the effect of fertilization on the quality and storability of vegetables. This study assessed the nutritional qualities of two commonly cultivated cabbage varieties as influenced by organic, mineral and organomineral fertilizers before and after storage.

MATERIALS AND METHODS

The field and laboratory experiments were conducted at the Teaching and Research Farm of Ladoke Akintola University of Technology, Ogbomoso, Nigeria. Ogbomoso, in the Guinea savannah zone of Southwest Nigeria. Two cabbage varieties (Copenhagen market and F1 Milor) which are widely cultivated and adapted were used. The seeds were collected from the Seed Project Company Limited, Adejia Road, Kano, Nigeria. Eight (8) types of fertilizers were used : four organic fertilizer types (neem organic fertilizer (NOF), cassava peel compost (CPC), sunshine unfortified fertilizer (SUF) and Alesinloye organic fertilizer; three organomineral fertilizers: Alesinloye organomineral fertilizer, sunshine fortified fertilizer (SFF) and pacesetter fortified fertilizer (PFF) were used. NPK 15:15:15 mineral fertilizer was included as conventional fertilizer and a control. The eight Fertilizer types were applied to the cabbage varieties as nitrogen sources as: T1 = 0.61 kg N/plot through NPK chemical fertilizer at the rate of 60kg N/ha; T2 = 0.61 kg N/ plot of neem organic fertilizer at the rate of 60kg N/ha; T3 = 0.80 kg N/ plot through Alesinloye organomineral fertilizer at 60kg N/ha; T4 = 0.69 kgN/ plot through sunshine organomineral fertilizer at 60kg N/ha; T5 = 1.09 kgN/plot through cassava peel compost organic fertilizer at 60kg N/ha; T6 = 2.40 kg N/ plot through Alesinloye organic fertilizer at 60kg N/ha; T7 = 0.69 kg N/ plot through pacesetter organomineral fertilizer at 60kg N/ha; T8 = 0.96 kg N/ plot through sunshine unfortified organic fertilizer at60kg N/ha; and T9 = No fertilizer (control). The experiment was laid out in split plot

fitted into randomized complete block design, replicated thrice. The two cabbage varieties formed the main plot treatment while nutrient sources were allocated into the subplots. Two seeds were sowed per hole at 0.5cm depth due to the small rounded nature of the seed at 50 cm by 50 cm apart. Water was provided for seedlings to minimize the environmental stress that occurred during sowing and to ensure better crop establishment in the first three weeks. The organic fertilizers were applied 2 weeks after sowing (WAS) while other fertilizers were applied at four weeks after sowing (4 WAS). Treatments were applied to the respective beds randomly. Weeding was carried out every two weeks; insects were controlled by spraying fortnightly with neem seed extract, at the rate of 40 ml / 20 L water.After three months, thirty - six (36) mature cabbage heads were selected from the field. The cabbage heads were cleaned with water to remove stones and dirt. The heads were packaged in polythene bags (2 cabbage heads/package), each head was tagged to track the respective treatment before keeping in the refrigerator at 6^0 C for 4 weeks. Data collection commenced at first week of storage and continued weekly until the fourth week. Data were collected on physical appearance (degree of rottenness and number of rotted leaves) and nutritional quality. Degree of rottenness was measured through visual appearance of the cabbage head and with the aid of colour chart, on a rating scale of 1 – 4, where; 1 – 4 represents green, yellowish green, slightly brown and brown, respectively. The dry matter was weighed after placing the harvested cabbage head in brown envelopes and drying in an oven at 65^0 C till a constant weight was obtained. The dried cabbage heads before and after storage from the various treatments was separately ground with a miley and passed through a 0.05 mm sieve. These were taken to the laboratory for analysis of N, P, K, Ca, Mg, vitamin C and crude protein contents. Total N was measured using Macro kjeldahl (IITA, 1982), the P and K contents of the plants were determined by wet digestion in nitric, sulphuric and perchloric acids. P was determined by vanadomolybdate yellow colorimetry method. Digested samples were diluted and used to determine the concentration of K using atomic absorption spectrophotometer, concentration of nutrients were expressed on the basis of percentage dry plant material (AOAC, 1990; 2005). The data collected were analyzed using Statistical Analysis Software procedure (SAS, 1999) for analysis of variance (ANOVA). Differences among treatment means were computed where applicable, using the Least Significance Differences (LSD) at 0.05 probability level.

RESULTS

Fertilizer types and storage had significant influence on the mineral quality of cabbage head. Fertilizer types and variety significantly influenced the degree of rotteness after 4 weeks of storage. Neem organic fertilizer produced the least number of rotted leaves while the control gave the poorest marketable appearance and highest number of rotted leaves (Table 1)

Sunshine and pacesetter organomineral fertilizer increased the CP content of cabbage head while NPK and neem decreased the CP content after 4 weeks of storage. The average CP content increased after 4 weeks of storage in both varieties. Fertilizer types, variety and storage influenced the vitamin C content of cabbage. F1 milor had higher vit. C before storage (61.45 mg/100g) compared to copenhagen with 57.60 mg/100g. After storage copenhagen retained more vit.C (-1.31 mg/100g) than F1 milor (-18.43 mg/100g), both varieties showed decrease in the vit. C content after 4 weeks of storage. Fertilizer types affected vit. C content of cabbage head.

.

Table 1: Effect of fertilizer types and variety on physical appearance of cabbage after storage.

Treatment	Copenhagen market		F1 milor	
	NRL	DR	NRL	DR
NPK	2	3	2	3
Neem	3	2	3	2
AA	3	2	3	2
SFF	3	3	3	3
CPC	4	3	4	3
PFF	3	2	3	2
SUF	3	3	3	3
Control	4	3	4	3
Mean	3.1	2.6	3.1	2.6
LSD (5%)				
Fert.	0.2	0.2	0.2	0.2
Var.	ns	ns	ns	ns
F x V	ns	ns	ns	ns

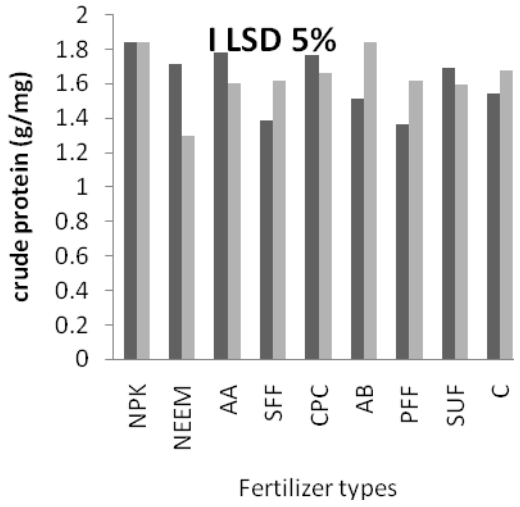
Where: AA = alesinloye organomineral; SFF = Sunshine organomineral; CPC = cassava peel compost; AB = alesinloye organic; PFF = pacesetter organomineral; SUF= sunshine organic; DR; degree of rotteness using the scale: 1 = green; 2 = yellowish green; 3 = slightly brown; 4 = brown and NRL; number of rottened leaves

Control (no fertilizer) had higher content (69.70 mg/100g) while NPK (70.40 mg/100g) recorded higher in F1 milor. After storage decrease in Vit C was recorded irrespective of the fertilizer type used. Ca content of cabbage was affected by fertilizer types, variety and storage. Sunshine organomineral resulted in the highest Ca (0.78 mg/g) in copenhagen with control recording the least while in F1 milor, control recorded 0.63 mg/g before storage while alesinloye organomineral recorded 0.43 mg/g. A decrease was recorded in alesinloye organomineral for both varieties and increase in neem organic for copenhagen (+0.02 mg/g) and F1 milor (+0.66 mg/g). Fertilizer types had significant effect on the Mg content of cabbage before and after storage. Without fertilizer (control) copenhagen had (0.10 mg/g) while F1 milor had (0.33 mg/g). Before storage, sunshine organomineral had the highest Mg value in copenhagen (0.42 mg/g) while the least was recorded in the control. In F1 milor, control had the highest value (0.33 mg/g) while neem and NPK recorded the least (0.22 mg/g). After 4 weeks of storage, it was observed that fertilizer types influenced the Mg content. Neem and NPK maintained the Mg content in F1 milor while in copenhagen, NPK, cassava peel, alesinloye organic and control showed higher Mg value after storage while other fertilizer types had lesser values after storage. P content of cabbage was influenced by fertilizer types and variety before and after storage. Organomineral fertilizers had the highest value of P in both varieties. Copenhagen recorded 0.60 in sunshine organomineral while F1 milor had 2.55 mg/g in alesinloye organomineral. There was an increase in P content of cabbage head after storage. The mean P content in copenhagen increased by +4.03 mg/g while F1 milor increased by + 0.36 mg/g. After storage, reduction was observed in the K content of cabbage head in both varieties. The nutritional content of cabbage indicated better response with fertilizer types which might be due to the importance of N in the chemical composition of

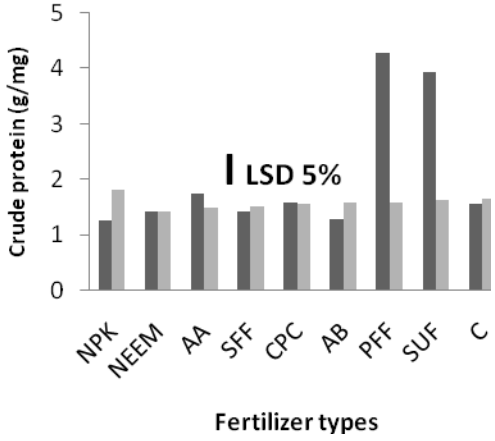
vegetables. The effect of fertilizer on the chemical composition of plant residue is due to the nutrients taken up by plants from fertilizers which are constituents of major organic compounds (Brandt and Molgaard, 2001). Highest crude protein, P, Ca and Mg contents of cabbage head were obtained from organomineral fertilizer and the vitamin C and K obtained in plant treated with organic fertilizer in both varieties agrees with the work of Brandt and Molgaard (2001). This might be due to the fact that N taken up by plants is converted into amino acids which are indispensable for biosynthesis of pertinacious substance, nucleic acid, alkaloids and other compounds. Also, N is a constituent of chlorophyll, some vitamins and hormones.

However, the variations obtained among the nutritional quality of the two cabbage varieties with and without fertilizer application might be due to the effect of the environment in which they are grown. The difference in P, K, Ca, Mg, crude protein and vitamin C content of cabbage varieties might also be due to the genotypic difference since they are grown under the same environment (Olaniyi and Fagbayide, 1999). Reduction in vitamin C content of cabbage head after four weeks in storage shows that vegetables deteriorate immediately after harvest irrespective of the storage method adopted (Babarinsa; 2000). Temperature and relative humidity are critical factors in the maintenance of quality during storage, which reconfirms the inconsistency of the mineral quality of cabbage head irrespective of the fertilizer type used. This agrees with the findings of Babatola and Olaniyi (1998) and Olaniyi *et al*. (2010). The minimal reduction in the quality of cabbage after storage is due to the supression of metabolic activities under low temperature in the refrigerator (Babarinsa, 2000).

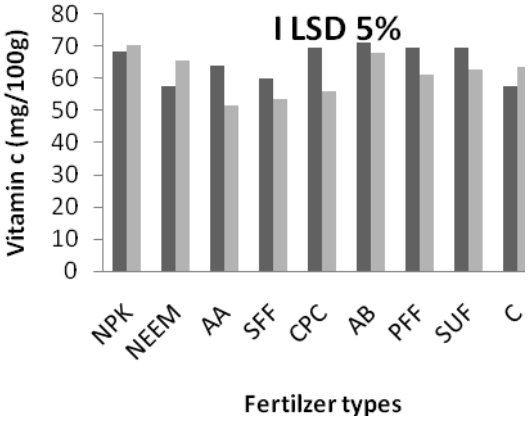
Rotteness and colour change of plant tissue is due to oxidation and enzymatic activities (Idowu, 2005). Neem organic fertilizer indicated better shelf – life of cabbage irrespective of the cabbage varieties. Bhardwaj *et al*. (2010) reported that increase in physiological loss in weight and rotting was low in fruits treated with 20% neem leaf extract and 100 ppm benzyladenine as compared to control and other treatments. This might be due to the fact that neem leaf extract check the growth of microbes that are responsible for rotting and higher metabolic rate which causes loss in weight through transpiration. However, the work of Lurie *et al.(*1986) and Idowu (2005) reported that cooling is the best means of delaying the senescence of perishables due to the supression of metabolic activities under lower temperature.The better performance in terms of mineral compositions obtained among the two varieties was in accordance with the work of Olaniyi and Akanbi (2008) and Olaniyi *et al.(*2010) who recommended the use of manure and organomineral fertilizers for the production of cabbage and vegetables, respectively

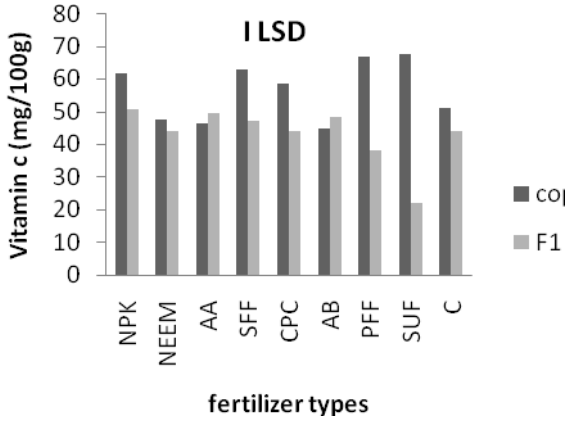


.



Crude protein content before storage crude protein content after storage





Vitamin C content before (left) and after storage (right).

Figure 1: Comparing effect of fertilizer types and variety on crude protein and vitamin C content of cabbage head before and after storage.
Where; AA = Alesinloye organomineral; SFF = Sunshine organomineral; CPC = Cassava peel compost; AB = Alesinloye organic; PFF = Pacesetter organomineral; SUF = Sunshine organic and C = Control.

Table 2: Effect of fertilizer types on mineral compositions of copenhagen market and F1 milor before and after storage.

Fertilizer types	Copenhagen market								F1 milor							
	P		K		Ca		Mg		P		K		Ca		Mg	
	BS	AS	BS	AS	BS	AS	BS	AS	BS	AS	BS	AS	BS	AS	BS	AS
NPK	0.21	0.96	2.37	2.16	0.47	0.4	0.18	0.2	0.33	0.76	3.31	2.74	0.41	0.5	0.22	0.22
NEEM	0.18	1.63	2.71	5.27	0.43	0.5	0.19	0.1	0.26	0.5	3.46	2.48	0.47	0.53	0.22	0.22
AA	0.19	3.39	3.02	2.56	0.48	0.3	0.25	0.2	2.55	0.83	2.94	0.59	0.63	0.48	0.4	0.2
SFF	0.6	0.7	6.42	5.51	0.78	0.5	0.42	0.2	0.25	0.9	3.2	0.61	0.67	0.51	0.22	0.23
CPC	0.22	0.21	2.69	2.85	0.45	0.4	0.18	0.2	0.83	0.7	2.8	0.63	0.65	0.53	0.37	0.26
AB	0.27	0.45	9.88	3.01	0.53	0.5	0.2	0.2	0.35	0.8	4.7	0.66	0.47	0.55	0.3	0.26
PFF	0.25	0.05	2.99	1.98	0.64	0.5	0.22	0.2	0.26	0.1	2.94	0.71	0.64	0.59	0.23	0.28
SUF	0.27	0.95	3.27	2.19	0.45	0.3	0.25	0.2	0.4	1.5	3.8	0.74	0.49	0.61	0.26	0.31
Control	0.07	0.36	0.89	1.92	0.22	0.5	0.1	0.2	0.2	1.4	2.3	0.77	0.4	0.63	0.21	0.33
Mean	0.27	1.3	3.8	3.05	0.49	0.4	0.07	0.2	0.58	0.94	3.27	1.1	0.54	0.55	0.07	0.26
LSD (5%)																
fertilizer	0.83	0.83	7.52	7.52	0.03	0	0.03	0	0.83	0.83	7.52	4.6	0.03	0.03	0.03	0.03
Variety	1.66	1.66	7.68	7.68	0.03	0	0.03	0.1	1.66	1.66	7.68	51.1	7.8	7.8	0.03	0.03
f x v	0.93	0.93	12.69	12.69	12.9	13	0.03	0	0.93	0.93	12.7	3.3	4.9	4.9	0.03	0.03

Where: AA = Alesinloye organomineral; SFF = Sunshine organomineral; CPC = Cassava peel compost; AB = Alesinloye organic; PFF = Pacesetter organomineral; SUF = Sunshine organic; BS= Before storage and AS= After storage.

CONCLUSION

The results obtained in this study confirmed that combination of readily available N from mineral fertilizer and slow releasing N from organic fertilizer (sunshine organomineral fertilizer) can increase the mineral content (Ca, Mg and K) of cabbage head before and after storage. Organomineral fertilizers such as pacesetter followed by sunshine and alesinloye compared well to NPK (15:15:15) and enhanced optimum nutritional compositions of cabbage varieties before and after storage. Neem fertilizer improved the storability of cabbage varieties. Despite the pre and post- harvest constraints encountered by the cabbage varieties used, F1 milor had better nutritional values than Copenhagen market with or without fertilizer, and therefore can be recommended as the better variety for Ogbomoso, South West, Nigeria.

REFERENCES

AOAC. 1990. Official methods of analysis, Washington DC. Association of official *Analytical Chemist*. Pp 1058.

AOAC. 2005. Official method of Analysis, Washington D.C. Association of Official *Analytical Chemists*. Chap 45. Pp 19.

Babarinsa FA. 2000. Reduction of zeight loss in valencia oranges using a brick wall cooler. Tropical Sciences 40: 92 – 94.

Babatola LA and Olaniyi JO. 1997. Effect of NPK 15:15:15 fertilizer level and plant spacing on performance and shelf - life of okra. In: proc. 15th *HORTSON Conference, NIHORT, Ibadan 8th April, 1997*.

Beecher C. 1994. Cancer preventive properties of varieties of *Brassica oleracea*: a review. Am J. Clin. Nutr. 1994; 59 (suppl): 1166S – 70S 1994.

Bhardwaj ML., Dhashora LK and Mukherjee S. 2010. Effect of neem leaf extract and Benzyladenine on post – harvest shelf – life of orange (*Citrus reticulata Blanca*). *J. Adv. Dev. Res*., Vol – 1 (1). Pp 32 – 37.

Bhardwaj ML., Raj, H. and Koul, BL. 2000. Yield response and economics of Organics sources and inorganic source in tomato (*Lycopersicon esculetum*), okra (*Hibiscus esculentus*), cabbage (*Brassica oleraceae var B. Oleracea var botytis*). *Indian Journal of Agricultural Science*; 70 (10). 653 – 656.

Brandt K., Mølgaard JP. 2001 Featured Article – Organic agriculture: does it enhance or reduce the nutritional value of plant foods? *Journal of the Science of Food and Agriculture* 81, 924-931.

FAO, 1988. Traditional Food Plant. Food and Agricultural Organisation of the United Nations, Rome, Italy.

FAO, 2000. Statistical database food and Agricultural Organization of the United Nations, Rome, Italy.

Freyman S., Toivonen, PM., Perrin PW., Lin WC. and Hall JW. 1991. Effect of Nitrogen fertilization on yield, storage losses and chemical composition of winter cabbage. Can. J. Plant Sci. 71: 943 – 946.

Grubben GJH. and Denton OA.2004. Plant resource of Tropical Africa and vegetables.*PROTA foundation, Wageningen, Netherlands / Backlmys Publishers, Leiden, Netherlands / CTA Wageningen, Netherlands*. 668 pp.

Idowu MA.2005. An investigation into some factors affecting quality and storage ccharacteristics of orunla / okra (Abelmoschus esculentus) powder. Ph D. Thesis, Ladoke Akintola University of Technology, Ogbomoso, Nigeria.

IITA. 1982. Automated and Semi- automated methods of soil and plant analysis manual series. IITA; Ibadan, Nigeria. No 7. Pp. 4 – 15.

Jim M. and Tony N. 2006. Cabbage growing Primefact 90 (replaces AGFACT. H8. 1.27. NSW Department of primary Industries (publ) Pp 1 - 7.

Köpke U. 2005 Organic foods: do they have a role? In *Diet Diversification and Health Promotion*, edit by Elmadfa I, in *Forum of Nutrition 57*, 62-72, Karger, Basel.

Muhammad D., Muhammad Q. and Maray A. 2007. Effect of Different levels of N, P and K on the Growth and Yield of Cabbage. *Journal. Agric Res., 2007*. 45 (2).

Olaniyi JO. and Akanbi WB. 2008. Effect of cultural practice on mineral compositions of cassava peel compost and its effect on the performance of cabbage (*Brassica oleracea L*). *Journal ofapplied Biosciences* 8(1): 272 - 279.

Olaniyi JO., Akanbi WB., Olaniran OA. and Ilupeju OT. 2010. Effect of organic, inorganic and organominerals on growth,fruit yield and nutritional composition of okra (*Abelmoscus esculentus*). *Journal of Animal and Plant Sciences vol 9 (1): 1* 1135 - 1140.

OMAF Factsheets. 2008. Fungal Diseases of Cruciferous Crops. *Agdex* 252 / 635.

OMAF Factsheets. 2010. Bacterial Diseases of Cruciferous Crops. *Agdex* 252 / 635.

Sagoo SK., Little, CL., Mitchell, RT. 2001. The microbiological examination of ready-to-eat organic vegetables from retail establishments in the United Kingdom. *Letters in Applied Microbiology* 33, 434-439.

SAS. 1999. Statistical Analysis Systems, version 8 of SAS institute. *Inc. cary, NC*.

Shika A. and Doug W. 2001. Cabbage postharvest handling and storage. Department of plant Science, *University of Saskatchewan*. *Publ. NSW Department of Primary industries.*

Slangen JH., Titulaer HH., Schoroen GJ., Quik P., Everaarts AP., De Mori CP. 1990. Nitrogen ffertilization of white cabbage. Field trials 1982 – 1987. Report 109. PAGW, Lelystad 59 pp.

Sørensen JN, Johansen, AS, Poulsen N. 1996. Influence of growth conditions on the value of crisphead lettuce. Marketable and nutritional quality as affected by nitrogen supply, cultivar and plant age. *Plant Foods for Human Nutrition* 46, 1-11.

Vogtmann H., Temperli, AT., Künsch, U., Eichenberger, MOP. 1984. Accumulation of nitrates in leafy vegetables grown under contrasting agricultural systems. *Biological Agriculture and Horticulture*, Vol. 2, 51-68.