



THE EFFECTS OF SWEET POTATO FLOUR ON THE QUALITY OF BISCUIT

M. A. Z. Islam¹, A. Kadira¹, L. Rani¹, M. M. Islam^{1*}, and M. S. Mahomud²

¹Department of Agricultural and Industrial Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

²Department of Food Engineering and Technology, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

Received 21 November 2012, revised 06 June 2013, accepted 26 June 2013

ABSTRACT

The present study was concerned with the preparation of biscuit and the effect of various levels of sweet potato powder on the quality of biscuit. Fresh sweet potato with peel and without peel were cleaned and chopped into small pieces and dried into two ways such as sun drying at 32°C-33°C for 2 days and oven drying at 65°C for 16 hours. The fresh sweet potatoes contained moisture 71%, protein 1.80%, fat 0.7%, ash 1.1%, and total carbohydrate 27.4%. Sweet potato flour contained moisture 8.13%, protein 2.5%, fat 0.58%, ash 1.67%, reducing sugar 11.85%, Non-reducing sugar 11.55%, total sugar 23.39% and total carbohydrate 87.12%. The composition of biscuits containing 20% sweet potato flour contained 04% moisture, 7.0% protein, 14.7% fat, 1.0% ash and 73.3% total carbohydrate contents. The biscuits containing different percentages of sweet potato flour were evaluated for their sensory attributes by panelists. The result revealed that the color, taste, texture, flavor and overall acceptability of biscuit containing sweet potato flour were equally acceptable with control biscuit. Statistical Analysis revealed that the overall acceptability of biscuit with sweet potato flour was significantly different from the control biscuit. This study has demonstrated that increasing levels of sweet potato flour in the biscuits affected the quality attributes. The findings of the present study may help in developing commercial processing technology for effective utilization sweet potato flour especially for manufacturing of biscuits.

Key words: Sweet potato, Flour, Biscuits, Proximate compositions.

INTRODUCTION

Sweet potato (*Ipomoea batatas* Lam.) commonly known as 'Misti Alu' belongs to the family Convolvulaceae and is an important source of starch. It is very popular among the poor people of the country because of its low cost. They contain high carbohydrate and vitamin-A and can produce more energy per day. Sweet potato (465kj/kg) provides higher energy than other roots and tuber staples such as potato (335kj/kg), yam (434kj/kg) and taro (432kj/kg). They contain low content of fat which makes them an ideal food for diabetes and persons who wish to shed excess fat (Bovell-Benjamin 2007; Chassy *et al* 2008; Lebot 2009). In Bangladesh about 307 thousand metric tons of sweet potatoes are produced in 32 thousand hectares of lands (FAOSTAT 2008). Some high yielding varieties available in Bangladesh are Tripti, Kamala sundori and Daulatpuri. According to skin color, local varieties of sweet potato are divided into two groups namely 'Local Sada' and 'Local Lal'. A major contribution which sweet potato makes to

human nutrition is the beta- carotene present in orange fleshed varieties. Beta-Carotene is converted into vitamin-A in the human body. Dark-orange varieties can contain up to 20,000 microgram beta-carotene of 100 g fresh storage root weight. Other crops such as wheat, rice, maize contain very little beta-carotene. Orange-flesh sweet potato is used in food diversification programs for all alleviation of vitamin-deficiency (Bovell- Benjamin, 2007; Teow *et al.* 2007). Sweet potato contains various micro-nutrients. Substantial quantities of vitamin-C, moderate quantities of thiamin (vitamin B1), riboflavin(vitamin B2), niacin and some quantities of pantothenic acid (vitamin B5), pyridoxine (Vitamin B6), folic acid and satisfactory quantities of Vitamin-E are present. Sweet potato contains some essential minerals and trace elements having especially high quantities of Iron. Two important mineral present are potassium and calcium (Woolfe-1992), Moderate quantities of zinc, sodium, Magnesium and manganese are also present (Antia *et al.* 2006; Suda *et al.* 1999). Sweet potatoes have been widely utilized as human food for centuries

*Corresponding author: M. M. Islam, Department of Agricultural and Industrial Engineering, Hajee Mohammad Danesh Science and Technology University, Dinajpur 5200, Bangladesh

have been appropriated for texture and flavor as well as some medicinal and tonic attributes. However, the awareness of sweet potato as a healthy food and as an important source of biological active substances with medical value because of present low fat but rich in proteins and dietary fibers (Manzi *et al.* 2001). In Japan 90% of starch from sweet potato is used to manufacture of starch syrup, glucose, isomerizes glucose syrup (high fructose syrup), lactic acid beverage as well as some other products in food industry such as distilled spirits called “shochu”. In China, starch is used in making pasta and some of alcoholic beverages. Non alcoholic juice is also made in Africa such as Uganda (Shingh *et al.*, 2004). Sweet potato is good for stomach ulcers and inflamed conditions of the colon. It is beneficial for low blood pressure. It may be helpful for hemorrhoid because of its high fiber content. It is a good food for people involved in heavy muscular work, since this food is high in vitamins and minerals. It may help prevent cancer in glands and organs with epithelial tissue due to its high Vitamin A content. It is a good food for diabetics, because it helps stabilize blood sugar levels (Woolfe 1992).

Although the utilization of sweet potato in many types of products such as in soups, sauces pickles etc are popular in many countries. However, information on the use of sweet potato flour in bakery products such as biscuits, breads and cakes is very scant. Taking the above points into consideration the presents study was under taken to achieve the following objectives: (i) to analyze the proximate composition of fresh sweet potato and sweet potato flour. (ii) To analyze the proximate composition of biscuits incorporated with sweet potato flour. (iii) To assess the effect of different percentages of sweet potato flour on the sensory quality of biscuits.

MATERIALS AND METHODS

The study was conducted in the laboratories of the Department of Food Engineering & Technology, Food Science & Nutrition, Food Processing & Preservation and Agricultural Chemistry and Biochemistry, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.

Fresh sweet potato: Fresh Sweet potato of white variety was collected from Local market. The Sweet potatoes were washed with clean water to remove dirt, sand and other undesirable materials before use.

Wheat flour: Commercial wheat flour of ‘Pata’ brand (12-13% moisture and 8-9% protein) was used for biscuit preparation.

Chemicals, solvents and ingredients: Several chemicals and ingredients were used. Wheat flour (12-13% moisture and 8-9% protein) was

commercial white flour, eggs, sugar, baking powder, shortening (dalda), sweet potato flour, salt, and other ingredients were procured from the local market. High density polyethylene bags were used for package and storage of samples. Other minor ingredients were used from laboratory stocks.

Preparation of Sweet potato flour

The sweet potato was processed to remove dirt and other field damaged portion. Cleaned sweet potato were chopped into small pieces with knife and blanched in hot water at 100°C for three minutes containing 2% salt and 0.01% citric acid. Then water was drained and sweet potatoes were spread in trays and dried in a sun up to 5-10% moisture level at 32°C-33°C for 2 days and also dried in oven at 65°C, 16 hours. After cooling to room temperature, the dried sweet potatoes were ground into flour in a grinder. Then they were sieved and packaged in polythene bags and stored at room temperature for further use in the preparation of biscuit. Finally, it was obtained four categories of sweet potato flour as follows:

- 1) Sun drying with peel sweet potato flour
- 2) Sun drying without peel sweet potato flour
- 3) Oven drying with peel sweet potato flour
- 4) Oven drying without peel sweet potato flour

Chemicals analysis of sweet potato flour and biscuits:

The fresh sweet potato, sweet potato flour and biscuit prepared by incorporating sweet potato flour were analyzed for moisture, protein, fat, ash, crude fiber, total sugar, titrable acidity, and pH and carbohydrate contents. The moisture, protein, fat, ash contents were determined as per the methods described Rangana (1994), AOAC (2000). The carbohydrate content was determined by subtracting the measured moisture, protein, fat, ash from 100 (Pearson 1976). All the determinations were done in triplicate and the results were expressed as the average values.

Product development

Formulation of biscuit incorporating sweet potato flour:

The basic formulation of sweet potato biscuits (Atkins, 1971) is in table1. The additions of wheat flour in the formulations were made with 10%, 20% and 30% of sweet potato flour.

Table 1: Basic formulation of biscuit on 2kg flour basis (30% ratio)

Ingredients	Quantity (g)
wheat flour	1400
Sweet potato flour	600
sugar	750
Vegetable oil(dalda)	500
soyabean	600
egg	4 nos.
salt	10
baking powder	10
vanilla essence	5 ml

Biscuit making procedure: Biscuits were prepared by wheat flour with 10%, 20% and 30% of different sweet potato flour samples in the basic formulation of biscuit (Table 1) as per method of Rajchel *et al.* (1975). The flour, sweet potato flour and other ingredient for each biscuit were weighed accurately and the sugar and shortening were mixed in a mixing machine for 20 minutes to produce a cream. In the next stages, other ingredient, and flour were mixed using at low speed (145 rpm) for 10 minutes to ensure even distribution of the components. The bowl was scrapped and butter were mixed for an additional two minutes at medium speed (250 rpm). Then the designer was designed biscuits. The biscuit were kept in tray and were baked in National forced convection oven for 40 minutes at 170°C.

Chemical analysis of biscuit containing Sweet potato flour: The biscuit containing 10%, 20% and 30% of sweet potato flours were analyzed for moisture content, protein, ash and crude fat as per the methods of AOAC (1975). Carbohydrate content of the biscuit samples was determined as total carbohydrate by difference method. All determinations were done in triplicate and the results were expressed as the average value.

Evaluation of biscuit by objective analysis: Biscuit volume was initially used as an important parameter of biscuit quality. The biscuit volume was determined by seed displacement method (Ott, 1987). Moisture content was determined according to the methods outlined in AOAC (1975). The weights and specific volume of baked biscuit were also measured.

Subjective (sensory) evaluation of biscuit: The symmetry and the characteristics of crust and crumb of the biscuits supplemented with bran samples were evaluated and recorded. Biscuits were evaluated organoleptically for color, flavor, texture, and overall acceptability. A 1-9 point hedonic rating test was also performed to assess the degree of acceptability of biscuit containing sweet potato flour in different level. Biscuits were presented to panelists randomly as coded samples. The panelists were asked to rate the sample for color, flavor, texture, and overall acceptability on a 1-9 point scale, where 9=Like extremely; 8=Like very much; 7= Like moderately; 6=Like slightly; 5= Neither like nor dislike; 4=Dislike slightly; 3= Dislike moderately; 2= Dislike very much; 1=Dislike extremely. The results were evaluated by analysis of variance and Duncan's New Multiple Range Test Procedures of the Statistical Analysis System (SAS, 1985).

RESULTS AND DISCUSSION

Composition of fresh sweet potato: The composition of sweet potato was shown in Table 2.

The fresh sweet potato contained moisture 71%, protein 1.8%, fat 0.7%, ash 1.1% and total carbohydrate 27.4%. The composition of fresh sweet potato under study was more or less similar to those reported by U.S. Department of Agriculture. They reported that the nutrient content of fresh sweet potato as follows: Moisture 72.84%, protein 1.65%, carbohydrate 24.28%, fat 0.3%, and ash 0.95%. The differences observed in these compositions may be due to varieties differences, agro-ecological condition, fertilizer use, methods of analysis etc.

Table 2. Composition of fresh sweet potato

Components	Amount
Moisture (%)	71.00
Protein (%)	1.80
Fat (%)	0.70
Ash (%)	1.10
Total carbohydrate (% by difference)	27.40

Composition of sweet potato flour

The analysis showed the composition of sweet potato flour treated with Sun drying without peel (Table 3) as moisture 8.13%, protein 2.5%, fat 0.58%, ash 1.67%, and total carbohydrate 87.12%. The moisture, protein, fat and ash content were more or less similar to those reported by Teow *et al.* (2007). They found that sweet potato flour have water content 8-9%, protein 2-3%, fat 0.50-0.59%, carbohydrate 86-93% and ash 1.3-1.7%. The differences observed in these compositions may be due to drying temperature, drying method, drying time, method of analysis etc.

Table 3. Composition of sweet potato flour (Sun drying without peel)

Components	Amount
Moisture (%)	8.13
Protein (%)	2.50
Fat (%)	0.58
Ash (%)	1.67
Reducing Sugar(%)	11.85
Non Reducing Sugar(%)	11.55
Total Sugar(%)	23.39
Total carbohydrate by difference (%)	87.12
Acidity	0.35
P ^H	5.95
Crude fibre	2.76
Vitamin C	0.024
Iron	0.114
Crude fiber	2.76

The effects of sweet potato flour on the physical properties of Biscuits: Preliminary studies were carried out on the Biscuits prepared by incorporating 0%, 10%, 20% and 30% sweet potato

flour in the formulations. The biscuits were evaluated for their weight, thickness, volume and moisture content and the result are presented in Table 4. Four levels of sweet potato flour that might be due to lower moisture content of sweet potato flour than those of wheat flour. The moisture content of control biscuits was higher and the volume of control biscuits was lower than others. Sundry without peel potato flour incorporated biscuits is more productive than those of control because of increasing weight, volume and decreasing the moisture content of final products. There was very little effect of addition of sweet potato flour on the thickness of the biscuits.

Composition of biscuits incorporated with Sweet potato flour: The composition of biscuits incorporated with different percentages of sweet potato flour as shown in Table 5. The carbohydrate content of biscuits increased with the increasing levels of sweet potato flour that might be due to lower moisture content of sweet potato flour. Moisture and protein content decreased with the increasing level of sweet potato flour. Ash content of sun dry with peel and oven dry with peel potato flour incorporated biscuits is higher than those of others.

The effects of different percentages of sweet potato flour on the sensory parameters of biscuits: The biscuits were prepared by incorporation of Sweet potato flour at 0-30% (weight/weight) and evaluate their sensory parameter. The panelists evaluated the colour, texture, flavour taste and overall acceptability of biscuits. The results are presented in Table 6. It was observed that overall acceptability of biscuits containing 20% sweet potato flour of sun dry without peel was higher than those containing 10%, 30% of sweet potato flour and control biscuits. Up to 20% of sweet potato flour gave the highest score for colour, flavour, taste and texture and after that decreased with increasing level of sweet potato flour. Within level of 0-30% of sweet potato flour, the highest score for colour was 9.10 with 20% of

sun dry without peel and lowest score of 5.6 with 30% of oven dry with peel Sweet potato flour. Similarly, the highest and lowest scores for texture were 8.12 and 5.37 at 20% of sun dry without peel and 30% of oven dry with peel of Sweet potato flour respectively. Finally, it was observed that the biscuits with 20% of sun dry without peel gave the highest total score of 8.31 while 30% of oven dry with peel gave the lowest total score of 5.95. Up to 20% level of sun dry without peel Sweet potato flour gave very good quality. However, the level up to 30%, biscuits had acceptable scores from our sensory evaluation.

Statistical sensory evaluation of biscuit: The biscuits added with 0, 10, 20 and 30% sweet potato flour were subjected to sensory evaluation by a panel of 30 tasters. The mean scores for colour, flavour, texture, taste and overall acceptability of the biscuits are presented in Table 7. A two way analysis of variance indicate that all these sensory attributes of different biscuits were significantly different and thus the biscuits samples showed varied degrees of acceptability in terms of colour, flavour, texture and overall acceptability.

As shown in Table 7, the DMRT test revealed that the texture of biscuits with 10% oven dry with peel sweet potato flour, 10% oven dry with peel sweet potato flour, 10% oven dry without peel sweet potato flour and 20% oven dry without peel sweet potato flour had no significant difference with that of control biscuits. The colour of biscuits with 30% sun dry with peel sweet potato flour and 20% sun dry without peel sweet potato flour had no significant difference with that of control biscuits. There was no significant difference between the taste of biscuits containing 20% sun dry without peel sweet potato flour and the control biscuits. Moreover, the overall acceptability of biscuits containing 10% oven dry with peel, 20% oven dry without peel, 20% sun dry without peel and 30% sun dry without peel were more acceptable than that of control biscuits and others.

Table 4. The effects of sweet potato flour in the weight, volume, thickness and moisture content of Biscuit

Biscuits type	Sweet potato flour (%)	Weight (g)	Volume (cc)	Thickness T(cm)	Moisture content (%)
Control (wheat flour)	0	08	06	04	05
	10	8.6	6.8	4.7	4.8
	20	9.8	7.4	4.8	4.2
Sun dry with peel	30	11.2	8.2	05	3.8
	10	9.0	6.5	4.8	4.5
	20	10.0	7.9	5.3	3.7
Sun dry without peel	30	11.3	8.9	5.0	3.3
	10	9.2	7.1	4.9	4.6
	20	9.9	7.8	5.1	4.1
Oven dry with peel	30	11.0	8.5	5.1	3.4
	10	8.8	6.6	5.0	4.7
	20	9.3	7.7	5.4	4.3
Oven dry without peel	30	10.7	8.4	5.1	3.8

Table 5. Composition of Biscuits containing sweet potato flour

Biscuits type	Sweet potato flour (%)	Moisture (%)	Protein (%)	Fat (%)	Ash (%)
Control (wheat flour)	0	05	8.64	15	1.1
Sun dry with peel	10	4.8	7.9	14.8	1.5
	20	4.2	7.1	14.7	1.6
	30	3.8	6.8	14.6	1.5
Sun dry without peel	10	4.5	7.9	14.8	1.1
	20	3.7	7.0	14.7	1.0
	30	3.3	6.8	14.7	1.0
Oven dry with peel	10	4.6	7.8	14.8	1.6
	20	4.1	7.1	14.7	1.8
	30	3.4	6.8	14.6	1.9
Oven dry without peel	10	4.7	7.9	14.7	1.1
	20	4.3	7.2	14.7	1.0
	30	3.8	6.8	14.6	5.1

Table 6. The effects of different parentages of sweet potato flour on the organoleptic properties of biscuits

Biscuits Types	Addition of sweet potato flour (%)	Score on*				
		Texture	Color	Flavor	Taste	Overall Acceptability
Control(Only Wheat flour)	0	8.25	7.14	7.10	7.11	7.40
	10	5.60	8.03	6.87	7.06	6.89
	20	6.38	7.12	7.03	8.33	7.22
Sun dry with peel	30	5.28	6.12	6.09	6.91	6.10
	10	7.30	7.28	6.05	8.00	7.12
	20	8.12	9.10	8.46	7.56	8.31
Sun dry without peel	30	7.30	7.46	5.03	6.09	6.47
	10	6.12	5.25	5.00	7.09	5.86
	20	7.32	6.96	7.06	7.15	7.12
Oven dry with peel	30	5.37	5.6	6.78	6.08	5.95
	10	6.78	6.78	7.84	7.09	7.12
	20	7.06	6.40	8.21	6.15	6.95
Oven dry without peel	30	7.37	7.09	7.00	6.95	6.34

*Score: 9=Like extremely; 8=Like very much; 7= Like moderately; 6=Like slightly; 5= Neither like nor dislike; 4=Dislike slightly; 3= Dislike moderately; 2= Dislike very much; 1=Dislike extremely.

Table 7. Mean sensory scores of biscuits

Biscuits type	*Mean scores on sensory attributes				
	Texture	Colour	Flavour	taste	Overall acceptability
Control biscuits(wheat flour only)	7.7 ^a	7.9 ^a	7.0 ^b	8.0 ^a	6.9 ^c
Biscuits with 10% sun dry with peel sweet potato flour	7.0 ^b	7.0 ^b	6.4 ^c	6.7 ^b	6.8 ^c
Biscuits with 20% sun dry with peel sweet potato flour	6.8 ^b	7.0 ^b	6.7 ^c	6.4 ^c	7.4 ^b
Biscuits with 30% sun dry with peel sweet potato flour	7.5 ^b	7.7 ^a	8.0 ^a	8.3 ^a	7.9 ^a
Biscuits with 10% sundry without peel sweet potato flour	6.9 ^b	6.5 ^c	6.7 ^c	6.8 ^b	7.5 ^b
Biscuits with 20% sun dry without peel sweet potato flour	7.9 ^a	8.1 ^a	6.4 ^c	8.0 ^a	7.9 ^a
Biscuits with 30% sun dry without peel sweet potato flour	7.5 ^b	7.5 ^b	7.0 ^b	7.5 ^b	7.4 ^b
Biscuits with 10% oven dry with peel sweet potato flour	7.7 ^a	7.0 ^b	6.8 ^c	6.8 ^c	7.8 ^a
Biscuits with 20% oven dry with peel sweet potato flour	7.0 ^b	7.5 ^b	6.6 ^c	6.9 ^c	6.8 ^c
Biscuits with 30% oven dry with peel sweet potato flour	7.0 ^b	7.5 ^b	7.5 ^b	7.6 ^b	6.8 ^c
Biscuits with 10% oven dry without peel sweet potato flour	7.8 ^a	7.0 ^b	7.0 ^b	7.5 ^b	7.5 ^b
Biscuits with 20% oven dry without peel sweet potato flour	7.9 ^a	7.0 ^b	6.4 ^c	7.0 ^b	7.9 ^a
Biscuits with 30% oven dry without peel sweet potato flour	7.4 ^b	6.9 ^c	6.9 ^c	7.0 ^b	7.5 ^b

CONCLUSION

The moisture and protein content of control biscuits was higher than that of Sweet potato flour biscuits. The carbohydrate content of sweet potato flour biscuits was higher than that of control biscuits. Sweet potato flour at different percentages on the sensory parameter of biscuits were evaluated and revealed that the texture, colour, flavour, taste and overall acceptability of biscuits were equally acceptable with control biscuits. Statistical analysis showed that the overall acceptability of biscuits containing various percentages of sweet potato flour was significantly different than the control biscuits. On the basis of sensory evaluation and DMRT test, it can be concluded that the biscuits containing 20% sundry without peel potato flour was the best quality product. This study has demonstrated that addition of increasing levels of sweet potato flour in the biscuits affected the quality attributes. The findings of the present study may help in developing commercial processing technology for effective utilization sweet potato flour especially for manufacturing of biscuits.

REFERENCE

- Almazan AM. 1995. Antinutritional Factors in Sweetpotato Greens. *Journal of Food Composition and Analysis* Vol. 8, pp. 363-368.
- Antia BS, Akpan EJ, Okon PA and Umoren IU. 2006. "Nutritive and Anti-nutritive Evaluation of Sweet Potato (*Ipomoea batatas*) Leaves", *Pakistan Journal of Nutrition* Vol. 5 (2), pp. 166-168.
- AOAC. 2000. Official Method of Analysis, Fourteenth edition. Association of Official Analytical Chemists. Washington, DC.
- Arthur Jr. JC and McLemore TA. 1955. Sweet potato dehydration: Effects of processing conditions and variety on properties of dehydrated products. *Journal of Agricultural and Food Chemistry*, 3, 782-787.
- Bovell-Benjamin AC. 2007. Sweet potato: A review of its past, present, and future role in human nutrition. *Advances in Food and Nutrition Research*, 52, 1- 48.

- Collado LS and Corke H. (1999). Accurate estimation of sweet potato amylase activity by flour viscosity analysis. *Journal of Agricultural and Food Chemistry*, 47, 832-835.
- Collado LS, Mabesa LB and Corke H. 1997. Genetic variation in color of sweet potato flour related to its use in wheat-based composite flour products. *Cereal Chemistry*, 74, 681-686.
- Collins JL, Liao JY and Penfield MP. 1995. Chemical, physical and sensory attributes of formed and frozen, baked sweet potato. *Journal of Food Science*, 60, 475-467.
- FAOSTAT. 2008. Agricultural data (last updated August 27, 2008). Rome, Italy: Food and Agriculture Organization of the United Nations. Available from: <http://faostat.fao.org/site/408/DesktopDefault.aspx?PageID=408>
- Huang AS, Tanudjaja L and Lum D. 1982. Content of α -, β -carotene, and dietary fiber in 18 sweet potato varieties grown in Hawaii. *Journal of Food Composition and Analysis*. 12: 147-151.
- Mais A and Brennan CS. 2008. Characterization of flour, starch and fibre obtained from sweet potato (kumura) tubers, and their utilization in biscuit production. *International Journal of Food Science and Technology*, 43, 373-379.
- Martin FW. 1984. Techniques and problems in small scale production of flour from sweet potato. *Journal of Agriculture of the University of Puerto Rico*, 68, 423-432.
- Singh S, Riar CS and Saxena DC. (2008). Effect of incorporating sweet potato flour to wheat flour on the quality characteristics of cookies. *African Journal of Food Science*, 2, 65-72.
- Teow CC, Truong VD, McFeeters RF, Thompson RL, Pecota KV and Yencho GC. 2007. Antioxidant activities, phenolic and β -carotene contents of sweet potato genotypes with varying flesh colors. *Food Chemistry*, 103, 829-838
- Truong VD. 1987. New developments in processing sweet potato for food. In: *Sweet Potato Research and Development for Small Farmers*, Mackay, KT., Palomar, MK. and Sanico, RT. (eds.), SEARCA, Los Banos, The Philippines, p. 213-226.
- Walter WM Jr. 1987. Effect of curing on sensory properties and carbohydrate composition of baked sweet potatoes. *Journal of Food Science*, 52, 1026-1029
- Woolfe AJ. 1992. *Sweet Potato: An Untapped Food Source*: Cambridge University Press, Camb, U.K. pp 1 – 39.