POTENTIAL OF PROCESSING POTATO FLAKES FROM POPULAR KENYAN POTATO VARIETIES

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ABSTRACT

Losses of potatoes are incurred during seasons of glut and farmers are forced to sell their produce to middlemen at low prices due to short storage life of the raw tubers. Processing potatoes after harvesting into dehydrated products such as potato flakes is one of the ways to overcome the problem of inadequate and inappropriate bulk storage of raw potatoes. Potato flakes are known to be shelf stable and hence assure users of the availability of the produce all year round. This study was instituted to establish the potential of processing potato flakes from selected popular Kenyan potato varieties. Five potato varieties (Tigoni, Dutch Robjin, Desiree, Kenya Mpya, and Sherekea) which are popular commercially were used in this study. The varieties were harvested after maturity and processed into potato flakes before evaluation of retained vitamin C, color, oil and moisture content, and sensory attributes. The varieties used in this study had dry matter contents ranging from 18.2% to 23.7%. Oil content of the flakes was significantly ($P \leq 0.05$) lower in Dutch Robjin (0.23%) compared to Desiree (0.76%). Oil content of flakes significantly ($p=0.011$) but negatively correlated ($r=-0.956$) with dry matter content of the raw potatoes. Reduced ascorbic acid (vitamin C) in raw tubers differed significantly ($P \leq 0.05$)

among the varieties ranging from 90.37 mg/100g in Kenya Mpya to 127.56 mg/100g in Sherekea. The vitamin decreased in flakes, the reduction being higher in Kenya Mpya (60.34%) and Sherekea (71.71%) compared to Tigoni (18.15%) and Desiree (23.26%). Overall, Dutch Robjin was the best variety for flakes followed by Desiree and Tigoni with regard to overall acceptability. Sherekea was unacceptable while Kenya Mpya was barely acceptable. Promotion of these varieties for flakes processing will not only diversify the range of potato products, but also add value to local potatoes.

Key words: Flakes, drum drying, reduced ascorbic acid, potato varieties.

INTRODUCTION

Potatoes produced in Kenya are used in homemade recipes and industrial processing of French fries, potato crisps, potato sticks and other related products (Abong', et al., 2010a). There are, however, considerable losses during seasons of glut and farmers are forced to sell their produce to middlemen at low prices due to short storage life of the raw tubers. Coupled with lack of appropriate cold storage facilities, many varieties of potatoes grown in Kenya are not suitable for production of fried products even after reconditioning from cold storage. They accumulate high amounts of reducing sugars leading to dark brown fries which are unacceptable to many consumers (Abong' et al., 2009a).

The position of potato in the world as an important food crop is well documented, being one of the staple foods providing food security to millions of the populace (CIP, 2012). In terms of utilization, potatoes are ranked second after maize in Kenya, and are a major food staple (MoA, 2009). Processing potatoes after harvesting into dehydrated products such as potato flakes is one of the ways to overcome the problem of inadequate and inappropriate on-farm storage of raw potatoes. Potato flakes are known to be shelf stable and hence assures users of the availability of the produce all year round (Neilson et al., 2006; Nayak et al., 2011; Boesch et al., 2012).

The process of converting potato into flakes involves many stages culminating in drum drying of potato slurry or mash which can be compared to precooked starchy baby foods, casein, and milk, maltodextrins and fruit pulps. In normal circumstances, potato slurry is spread on the surface of a heated drum with steam condensing inside the drum. Heat is transferred through the metal of drum and moisture is evaporated usually with appropriate scraping device from the dried slurry adhering on the drum (Kakade and Ali, 2011).

Potato flakes have wide range of uses including thickening agent (Van Hecke, 2012); extruded products (Dushkova et al., 2011); fabricated potato chips; snack pellets; battered breaded products, and potato powder (Kakade and Ali, 2011). In our unpublished data on potato flakes survey, there exist only two brands of potato flakes in Kenya, an imported brand from the United States of America and a locally packaged brand whose source is unclear (Abong' and Kabira, 2012). It was difficult to establish if any of the local varieties are used in processing. This study was instituted to establish the potential of processing potato flakes from selected popular Kenyan potato varieties.

MATERIALS AND METHODS

Raw potatoes for processing

Five potato varieties which have previously been found to have good processing characteristics (Abong' et al., 2009b, Abong' et al., 2010b) were used in this study. Three established varieties: Tigoni, Dutch Robjin, Desiree and two newly released varieties, namely Kenya Mpya and Sherekea were grown under standard cultural conditions at the National Potato Research Center, Tigoni between April and August 2012. The crop was dehaulmed after maturity and harvested after two weeks. Tubers were cured for two more weeks in a dark store under ambient air conditions before processing. Dry matter and reduced ascorbic acid contents were analyzed in raw tubers and processed flakes.

Processing of potato flakes

About 5 kg of fresh potatoes from each of the five varieties were hand-peeled using a knife, trimmed and washed with clean water to remove surface dirt before cutting into 20–30 mm size. The potatoes were cooked by boiling until ready (just when a fork could penetrate with minimal force) before being converted into a mash using a cooking stick. A single drum dryer (IOT7578 SERIES OCD, Renold Limited, Germany) comprising a hollow drum allowing for introduction of steam was used for dehydration. The drum was made of stainless steel with a length of 300 mm, and an outer diameter of 320 mm, the effective area of drum surface available for drying being 3.02 m^2. The drum speed was set at 10 rpm and a scraper blade fitted to the drum so that the residence time of feed on drum surface was 10 s. As the drum rotated towards the scraper blade, the potato mash dried and was scraped out as a thin layer of dry material from the surface of the drum. The dried mash was broken into smaller particles, packaged and sealed in flexible polyethylene bags (300 gauge) after cooling to 20-25^{o}C.

Dry matter and moisture content: Dry matter and moisture contents of raw potatoes and processed flakes were determined on triplicate samples by standard analytical methods (KEBS, 2007).

Determination of reducing sugars of raw tubers

Reducing sugars levels were determined in the raw potato tubers as per the method described by Abong' et al. (2011a).

Oil content of potato flakes: The oil content was determined by extraction of 2.5 g of finely ground samples of flakes in a Soxhlet apparatus for 8 hours using analytical grade petroleum ether (boiling point 40-60 ^{o}C) according to the method described by KEBS, 2007 and the oil content calculated as a percent.

Potato flakes color: Flakes color was determined using a color spectrophotometer (NF 333, Nippon Denshoku, Japan) in the Commission International de l'Eclairage (CIE) $L*a*b*$ scale described by Abong et al., 2011a).

Determination of vitamin C: Vitamin C was determined as Reduced Ascorbic Acid (RAA) in raw and processed flakes by indophenol dye as described by Masamba and Nguyan (2008).

Sensory analysis: Potato flakes from each variety were coded and samples presented to 10 panelists familiar with processed potato products. Panel members scored for color, taste, mouth feel, aroma, and overall acceptability on a 7-point hedonic rating scale with 1= dislike very much to 7 = like very much (Larmond, 1977). A score of 4 was the lower limit of acceptability.

Data analysis: Analytical data obtained for each parameter were subjected to analysis of variance (ANOVA) for comparison of means and significance differences tests at 5% level of significance using Statistical Analysis System (SAS version 9). Significant differences were considered at $P \leq 0.05$. Pearson correlation was performed between dry matter of raw tubers and oil content of flakes, sensory color scores and laboratory color analysis.

RESULTS AND DISCUSSION

Variation in raw potato tuber dry matter content

The varieties used in this study had dry matter contents ranging from 18.2% in Desiree to 23.7% in Dutch Robjin. Dry matter contents of Desiree and Kenya Mpya were significantly ($P<0.0001$) lower compared to Sherekea, Tigoni and Dutch Robjin (Figure 1). Dry matter content of raw potato is an important parameter to be considered especially if the tubers are meant for processing. Potato dry matter content is influenced by among other factors the variety. Dry matter influences the starch matrix and content and hence functional properties of processed products (Frančáková et al., 2011). Higher dry matter content means that the processor is assured of good textural properties and higher yield (Burton, 1989). Fat content correlates negatively with dry matter content especially in cases where deep-oil frying is involved (Pedreschi et al., 2010; Abong' et al., 2010b). In case of processing flakes, it means that there will be less energy consumption, time and higher yields when dehydrating the variety Dutch Robjin compared to Desiree.

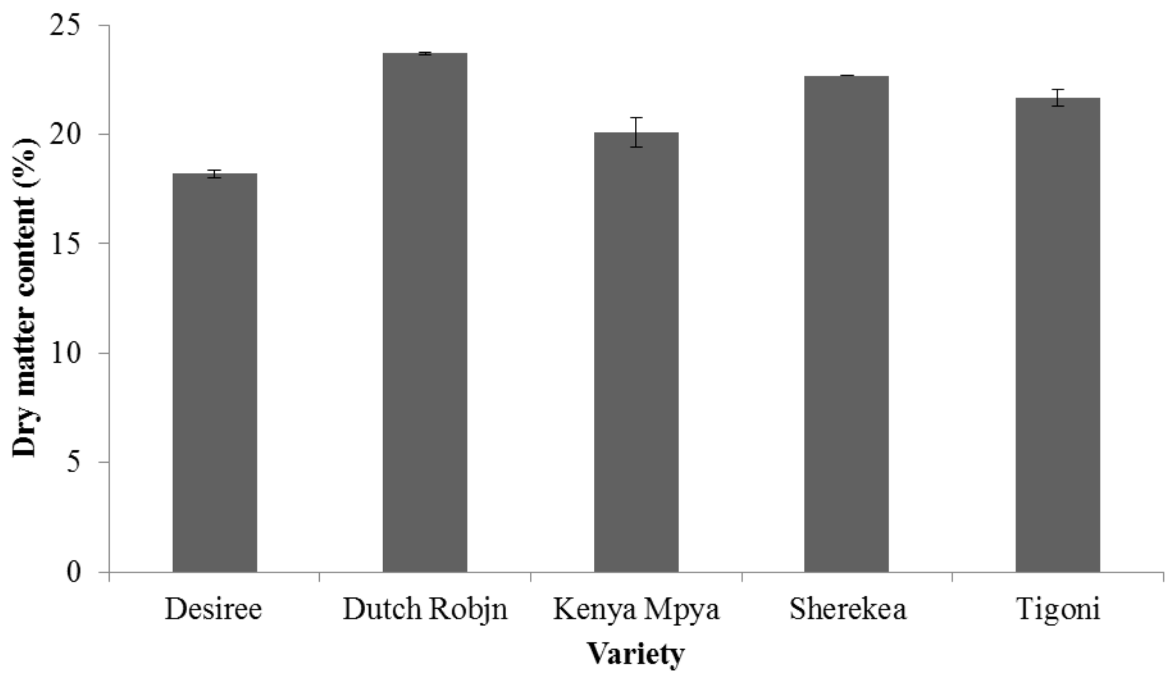

Figure 1: Dry matter content of Desiree, Kenya Mpya, Sherekea, Tigoni and Dutch Robjin. The bars indicate standard error of the means.

Attributes of potato flakes

Oil and moisture content of dehydrated flakes

The moisture content and oil content (dry weight basis) of flakes differed significantly (P≤0.05) from the five varieties used in processing (Table 1). Oil content of the flakes were significantly lower in Dutch Robjin (0.23%) compared to Desiree (0.76%). On the contrary, moisture content of flakes from Kenya Mpya, Sherekea and Tigoni did not significantly (P>0.05) differ from each other. This was the same for Desiree and Dutch Robjin, flakes moisture content did not have any particular varietal pattern. Oil content significantly (p=0.011) but negatively correlated (r=-0.956) with dry matter content of the raw potatoes.

Oil content in potato that has not undergone any type of frying is always low as confirmed with these dehydrated flakes in the current study. It is, however, important to note that the oil present in potato product however small it may be is a critical determinant of flavor and shelf-life (Woolfe 1987; Ziaiifar *et al.,* 2008). Potato flakes therefore provide low- oil products that can be used in a variety of food preparations. The low moisture content of the flakes ranging from 10.21% in Desiree to 11.65% in Kenya Mpya makes it possible for long period of storage. The lower the moisture, the longer the product can store since the water activity will not support oxidation or microbial activities so long as the packaging is suitable (Marsh and Bugusu, 2007; Abong' et al., 2011b).

Table 1: Oil and moisture contents of flakes from five Kenyan varieties

Variety	Oil content (%)[1]	Moisture Content (%)
Desiree	0.76 ± 0.08a	10.21 ± 0.30b
Dutch Robjin	0.23 ± 0.02d	10.85 ± 0.21b
Kenya Mpya	0.50 ± 0.14b	11.65 ± 0.78a
Sherekea	0.32 ± 0.03c	11.35 ± 0.91a
Tigoni	0.53 ± 0.04b	11.40 ± 0.57a

[1]Oil content values are expressed on dry weight basis (dwb)

Values are means of duplicate determinations± standard deviation

Values with similar letters in the same column are not significantly different at 5% level of significance

Effect of processing on reduced ascorbic acid (vitamin C) content

Reduced ascorbic acid in raw tubers differed significantly (P≤0.05) among the varieties ranging from 90.37 mg/100g in Kenya Mpya to 127.56 mg/100g in Sherekea. The levels, however, reduced significantly (P≤0.05) when the tubers were processed into flakes. The reductions were higher in Kenya Mpya (60.34%) and Sherekea (71.71%) compared to Tigoni (18.15%) and Desiree (23.26%).

Table 2: Reduced ascorbic acid (mg/100g, dry weight basis) in raw potato tubers and dehydrated flakes

Variety	Raw tubers	Potato Flakes	Reduction (%)
Desiree	126.60 ± 0.85a	97.15 ± 4.55a	23.26
Dutch Robjin	117.73 ± 4.90b	72.43 ± 1.05c	38.48
Kenya Mpya	90.37 ± 0.48d	35.85 ± 3.15d	60.34
Sherekea	127.56 ± 2.42a	36.09 ± 1.40d	71.71
Tigoni	106.91 ± 2.70c	87.51 ± 3.5b	18.15

Values are means of duplicate determinations± standard deviation

Values with similar letters in the same column are not significantly different at 5% level of significance

Potatoes are known to have high levels of vitamin C matching or surpassing some fruits. The vitamin C in potato tubers and its products is readily available and easily absorbed by the human body (Yoshitaka et al., 2012). The Irish poor for instance relied on the potato almost exclusively as the main source of vitamin C to an extent that the great famine that wiped potatoes caused widespread scurvy and other infections (Geber and Murphy, 2012). The variation in vitamic C is largely due to cultivar (Murniece et al., 2011; Abong et al., 2011, Lombardo et al., 2012). The levels of the vitamin can, however, be influenced by cultivation system indirectly through control of photosynthesis and metabolism of precursors such as sugars, environmental conditions and cultural practices such as pest control (Lee and Kader, 2000; Marek and Krystyna, 2012). The levels of vitamin C in the current study compare with those reported by Lombardo et al. (2012) which ranged from 49 to 74 mg/100g fresh weight basis, but are higher than those reported by Murniece et al. (2011) of 10-15 mg/100g fresh weight. Vitamin C is among the most heat-sensitive vitamins during thermal processing or extrusion (Riaz et al., 2009). The loss of the vitamin during dehydration is attributed to irreversible oxidation and thermal destruction that occurs during drying (Vega-Ga´lvez et al., 2008; Mrad et al., 2012). The effect of thermal dehydration is variety specific, probably due to differences in individual cell matrix that make up a given potato variety.

Color parameters of the flakes

Flakes color differed significantly (P≤0.05) among the varieties (Table 2). Lightness parameter was least in Desiree (78.58) and highest in Dutch Robjin (84.78). In all cases the lightness parameter was relatively high and therefore all the varieties gave good color. Redness parameters were all negative indicating less browning among the varieties. Yellowness parameter ranged from 14.7 in Sherekea to 27.80 in Desiree. The color of flakes and any food product is of utmost importance since it determines the acceptability of the product (Wang-Pruski and Nowak, 2004; Pedreschi et al., 2006). Color of processed potato products is determined before harvest by the kind of cultural practices such as fertilization, harvesting time and maturity. These activities influence the reducing sugar content which reacts at high temperatures with free amino acids to cause browning (Abong' et al., 2009a; Abong' et al., 2011a; Halford et al ., 2012). Extensive browning did not occur in flakes as shown by high lightness and low redness parameters. Since light flakes are preferred by consumers (Kakade and Ali, 2011), it is expected that they will be acceptable as far as perceived color is concerned.

Table 2: Color parameters for flakes from five selected potato varieties[1]

Variety	L*[2]	a*[2]	b*[2]
Desiree	78.58 ± 1.51c	-0.80 ± 0.00a	27.80 ± 1.23a
Dutch Robjin	84.78 ± 0.67a	-4.08 ± 0.17d	21.88 ± 1.63b
Kenya Mpya	83.50 ± 3.73a	-2.00 ± 0.22c	15.83 ± 1.12cd
Sherekea	82.03 ± 0.58b	-1.25 ± 0.31b	14.70 ± 1.97d
Tigoni	81.70 ± 0.88b	-2.15 ± 0.19c	17.55 ± 2.37c

[1]Values are means of four determinations ± standard deviation

[2]Values with similar letters in the same column are not significantly different at 5% level of significance

Sensory attributes of flakes from five Kenyan varieties

Table 3 indicates variations in sensory attributes of flakes from five potato varieties. Sensory color scores significantly differed ($P \leq 0.05$) among the varieties being lowest in Sherekea (3.4) and highest in Dutch Robjin (5.5). Scores for Desiree, Kenya Mpya and Tigoni did not, however, differ significantly meaning that panelists did not notice any apparent differences. On the other hand, flakes from Sherekea were rejected on the basis of color, scoring below 4 which was the minimum lower limit. There was no significant ($P > 0.05$) correlation between sensory color score and any of the color parameters (*L*, a** and *b**) implying that it is not possible to simply use the objective measurements to predict consumer choice of the flakes by use of color. Scores for taste were significantly higher in flakes processed from Desiree and Ducth Robjin and lower in

Sherekea and Kenya Mpya. Taste of the flakes from Sherekea, Kenya Mpya and Tigoni was not acceptable.

Table 3: Sensory attributes of flakes from five selected potato varieties[1]

Variety	Color[2]	Taste[2]	Mouth feel[2]	Aroma[2]	Overall acceptability [2]
Desiree	4.8 ± 0.8b	4.0 ± 0.9a	4.4 ± 0.8ab	4.4 ± 0.6b	4.7 ± 0.8b
Dutch Robjin	5.5 ± 1.1a	4.2 ± 1.1a	4.6 ± 1.1a	5.0 ± 1.2a	5.1 ± 1.2a
Kenya Mpya	4.7 ± 1.4b	3.3 ± 1.6cb	3.9 ± 1.2cd	4.1 ± 1.3b	3.9 ± 1.1c
Sherekea	3.4 ± 0.9c	3.2 ± 0.9c	3.7 ± 0.6d	4.0 ± 1.4b	3.4 ± 1.0d
Tigoni	4.6 ± 1.4b	3.6 ± 0.9b	4.2 ± 1.2bc	4.1 ± 1.0b	4.0 ± 1.1c

[1]Values with similar letters in the same column are not significantly different at 5% level of significance

[2]Evaluation was done on 7-point hedonic scale. A score of 4 was the acceptable lower limit

Sensory scores for the mouth feel and aroma of flakes significantly ($p \leq 0.05$) differed with the variety, being highest in Dutch Robjin and lowest in Sherekea. Whereas all the flakes were acceptable in terms of flavor, Sherekea (3.7) was unacceptable while Kenya Mpya (3.9) was barely acceptable. Overall, Dutch Robjin with a score of 5.1 was the best variety for flakes followed by Desiree (4.7) and Tigoni (4.0), respectively. Sherekea (3.7) was unacceptable while Kenya Mpya (3.9) was barely acceptable.

CONCLUSION

Generally, acceptable potato flakes were processed from the five Kenyan potato varieties selected for this study. Dutch Robjin, Desiree and Tigoni produced excellent flakes compared to Kenya Mpya which was barely acceptable while Sherekea was unacceptable. Promotion of these varieties for flakes will not only diversify range of potato products, but will also add value to local potatoes.

ACKNOWLEDGEMENTS

The authors acknowledge financial support from Kenya Agricultural Productivity Programme and Agribusiness Project (KAPAP) and the National Potato Research Centre (KARI). Technical support from J. M'thika, R. Kamau and B. Muroki from the Department of Food Science, Nutrition and Technology, University of Nairobi, and C. Muchoki, B. Kawili and N. Ngone from National Potato Research Centre (KARI), Tigoni is appreciated.

REFERENCES

Abong, G.O**.,** M.W. Okoth, E.G. Karuri, J.N. Kabira and F.M. Mathooko, 2009a. Levels of reducing sugars in eight Kenyan potato cultivars as influenced by stage of maturity and storage conditions. J. Anim. Plant Sci., 2 (2): 76-84.

Abong', G.O., Okoth, M.W., Karuri, E.G. Kabira, J.N. and Mathooko, F.M. 2009b. Evaluation of selected Kenyan potato cultivars for processing into French fries, 2(3): 141 – 147.

Abong', G.O., Okoth, M.W., Imungi, J.K. and Kabira, J.N. (2010a). Consumption patterns, diversity and characteristics of potato crisps in Nairobi, Kenya. *J. Applied Biosci. 32: 1942 – 1955*.

Abong', G.O., Okoth, M.W., Imungi, J.K. and Kabira, J.N. (2010b). Evaluation of selected Kenyan potato cultivars for processing into potato crisps. Agric. & Biol. J. North Amer. 1(5): 886-893.

Abong', G.O., Okoth, M.W., Imungi, J.K. and Kabira, J.N. (2011a). Effect of slice thickness and frying temperature on color, texture and sensory properties of crisps made from four Kenyan potato cultivars. *Am. J. Food Technol. 6 (9): 753-762.*

Abong', G.O., M.W. Okoth, J.K. Imungi and J.N. Kabira, 2011b. Effect of packaging and storage temperature on the shelf life of crisps from four Kenyan potato cultivars. Am. J. Food Tech. 6, (10): 870-881.

Abong', G.O. and J.N. Kabira, 2012. Diversity and Characteristics of Potato Flakes in Nairobi and Nakuru, KenyaGlobal Journal of Science Frontier Research Agriculture and Veterinary Sciences, 12 (10): 35-39

Boesch I. 2012. Preferences for Attributes of Industrial Potatoes: An Empirical Investigation of the Swiss Market. Am. J. Pot Res (2012) 89:199–206.

Burton, W.G. (1989). The potato.3rd ed. Longman Group UK, Ltd. pp. 286-360.

Dushkova, M.A., Menkov, N. D. and Toshkov, N.G. (2011) "Functional Characteristics of Extruded Blends of Potato Flakes and Whey Protein Isolate," *International Journal of Food Engineering*: 7: Iss. 6, Article 12.

Frančáková, H., Líšková, M., Bojňanská,T. and Mareček, j. 2011. Changes of carbohydrates complex influenced by the storage time. JMBFS. 1 (3) 446-454

Geber, J. & Murphy, E. 2012. Scurvy in the great Irish famine: Evidence of the vitamin C deficiency from the mid-19th Century skeletal population. American Journal of Physical Anthropology, 148 (4): 512-524.

Halford, Nigel G.; Curtis, Tanya Y.; Muttucumaru, Nira; et al. the acrylamide problem: a plant and agronomic science issue. J. Exp. Botany, 63 (8): 2841-2851.

International Potato Centre (CIP). 2012. Potato. www.cipotato.org/potato. Accessed on 3-8-2012.

Kakade, R. H. and Das, H. and Ali, S. 2011. Performance evaluation of a double drum dryer for potato flake production J Food Sci Technol. 48 (4):432–439.

Kenya Bureau of Standards (KEBS). (2007). Potato crisps specifications. KS 1094-1: 2007. KEBS, Nairobi.

Lee, S. K., & Kader, A. A. 2000. Preharvest and postharvest factors influencing vitamin C content of horticultural crops. Postharvest Biology and Technology, 20(3), 207–220.

Lombardo, S., Pandino, G. & Mauromicale, G. 2012. Nutritional and sensory characteristics of ‘‘early’’ potato cultivars under organic and conventional cultivation systems. Food Chemistry 133 (2012) 1249–1254

Marek, G. & Krystyna, Z. 2012.Vitamin C content in Tubers of as influenced by insecticide Application. Polish Journal of Environmental Studies. 21(4): 1101-1105.

Marsh, K. and B. Bugusu, 2007. Food packaging-roles, materials, and environmental issues. J. Food Sci., 72 (3): 39-55.

Masamba, K. G. and Nguyen, M. 2008. Determination and comparison of vitamin C, calcium and potassium in four selected conventionally and organically grown fruits and vegetables African Journal of Biotechnology Vol. 7 (16), pp. 2915-2919.

Ministry of Agriculture (MoA). (2009). Mainstreaming the potato crop from orphan crop status. Proceedings of Round Table Africa (RTA) potato stakeholders’ workshop, 8th May 2009, Nairobi, Kenya.

Mrad, N.D., Boudhrioua, N., Kechaou, N., Courtois, F. & Bonazzi, C. 2012. Influence of air drying temperature on kinetics, physicochemical properties, total phenolic content and ascorbic acid of pearsfood and bioproducts processing 9 0 (2 0 1 2) 433–441.

Murniece, I., Karklina, D., Galoburda, R. Santare, D., Skrabule, I., Costa, H.S. 2011. Nutritional composition of freshly harvested and stored Latvian potato (Solanum tuberosum L.) varieties depending on traditional cooking methods. Journal of Food Composition and Analysis 24 699–710

Nayak, B., Berrios, J.J., powers, J.R., Tang, J and Ji, Y. 2011. Colored potatoes (*solanum tuberosum* l.) dried for antioxidant-rich value-added foods. J Journal of Food Processing and Preservation **35** : 571–580.

Neilson, A.P., H.F. Pahulu, L.V. Ogden and O.A. Pike, 2006. Sensory and nutritional quality of dehydrated potato flakes in long-term storage. J. Food Sci., 71 (6): s461-S466.

Pedreschi, F., León, J., Mery, D., & Moyano, P. (2006). Implementation of a computer vision system to measure the color of potato chips. Food Research International, 39, 1092–1098.

Pedreschi, F., Segtnan, S V.H., Knutsen, H.. 2010. On-line monitoring of fat, dry matter and acrylamide contents in potato chipsusing near infrared interactance and visual reflectance imaging Food Chemistry 121: 616–620.

Riaz, Mian N.; Asif, Muhammad; Ali, Rashida. 2009. Stability of Vitamins during ExtrusionCritical Reviews in Food Science and Nutrition 49(4): 361-368.

Wang-Pruski, G. and Nowak, J. 2004. Potato after-cooking darkening. Am. J. Potato Res. 81:7-16.

Woolfe, J.A., 1987. The potato in the human diet. Cambridge University Press, Cambridge, UK., pp: 19-54.

Yoshitaka, K., Chihana, H., Mizuki, I., Handa, S., Mugita, H., Maruyama, N., Koga, H & Ishigami, A. 2012. Bioavailability of vitamin C from mashed potatoes and potato chips after oral administration. British Journal of Nutrition, 107(6): 885-892.

Ziaiifar, A.M., N. Achir, F. Courtois, I. Trezzani and G. Trystram, 2008. Review of mechanisms, conditions, and factors involved in the oil uptake phenomenon during the deep-fat frying process. Int. J. Food Sci. Technol., 43: 1410-1423.

Van Hecke, E., Nguyen, P-U., Clausse, D. and Lanoiselle, J-L. 2012. Flow behaviour of carrot puree: modelling the influence of time, temperature and potato flakes addition. International Journal of Food Science and Technology, 47, 177–185.

Vega-Ga´lvez, A., Lemus-Mondaca, R. Bilbao-Sa´inz, C. Fito, P. Andre´s, A. 2008. Effect of air drying temperature on the quality of rehydrated dried red bell pepper (var. Lamuyo). Journal of Food Engineering 85: 42–50.