International Journal of Multidisciplinary Approach and Studies

ISSN NO:: 2348 – 537X

Development and Quality Evaluation of Baked Potato Chips in Microwave

Geeta Dewangan[*] & Yashwant Kumar[**]

[*]*Department of Food Process Engineering, SHIATS Allahabad, U.P., India*
***Assistant Professor, Dept. of FPT, Bilaspur University, Bilaspur, Chhattisgarh, India*

ABSTRACT:

The study was conducted to develop microwave baked potato chips and to evaluate the effect of microwave power, baking time and slice thickness on chemical and quality characteristics such as moisture, crude fat, protein content, sensory and overall acceptability (OAA) of potato chips. The local cultivar of potato was selected and cut in three different thicknesses 1±10% mm, 2±10% mm and 3±10% mm, respectively. Slices were baked at microwave power (60, 80, 100 watts) for (40, 50, 60sec). It was found that microwave power and baking time had significant ($p<0.05$) effects on crude fat and moisture content. For protein content the interaction of microwave power and baking time had non-significant ($p>0.05$) effect. The optimum conditions for best quality chips were found to be 100 W, 60sec and 3±10% mm thick slices. At this condition the values for crude fat, protein, moisture content and overall acceptability score were found to be 0.20%, 3.90%, 1.7% and 8.15 respectively.

Keywords: *Potato chips, microwave processing, baking time, sensory & overall acceptability.*

INTRODUCTION

Potato *(Solanum tuberos*) is a starchy, tuberous crop of the Solanaceae family. Potato contains about 80% water and 20% dry matter. A major portion of dry matter is starch and sugar that constitutes 16% on fresh wet basis, crude protein content is 2% (Singh *et al.*, 2007). In countries where potato consumption is high this vegetable can make a significant contribution to health as a protein source (Woolfe, 1986; and Horton & Sawyer, 1985). Due to the dietary quality of tuber nitrogen, 100 g of boiled potatoes supplies 8-13% and 6-7% of the FAO-WHO recommended daily allowance of nitrogen for children and adults, respectively (McCay *et al.*, 1987). The predominant form of the carbohydrate present in it is starch. The starch provide bulk, offers protection against colon cancer, improves glucose intolerance and insulin sensitivity, lowers plasma cholesterol and triglycerides concentration, reduces fat storage (Tamaki *et al.*, 2003). Potato is world's most widely grown tuber crop and for U.P. region production was 2.6 million tonnes from an area of 0.14 thousand hectare with an average productivity of 180.7 quintal per hectares in 2005-06 (Marwaha and Sandhu, 2007). Since potatoes need to be baked, boiled, fried, or otherwise cooked before consumption, it is of interest to determine to what extent exposure to heat affects nutritive value of the proteins. Potatoes are processed into a variety of product such as mashed, potato chips, fries, deep frozen and dehydrated product like flakes (Tamaki *et al.*, 2003). Potato chips are a thin slice of potato, deep fried or baked until crisp or crunchy. It serves as an appetizer, side dish or snack. Potato chips have been popular salty snacks for 150 years, basic chips are cooked and salted but manufactures can add wide variety of flavoring herbs, spices,

cheese, color and artificial additives. The fat content of raw and cooked potatoes is very low, whereas in fried products the calorific value is significantly increased. During frying, the water present in the raw material evaporates, and is partially replaced by oil, constituting up to 40% of the finished product, and consequently influencing its properties. High oil content is therefore a major factor affecting consumer acceptance of oil-fried products today and the low fat food products are becoming more popular (Bunger *et al.*, 2003). A number of reactions occur in the frying oil when foods are fried; causing oxidative and hydrolytic degradation and polymerization of the oil. Losses of both amino acid and sugar (specially reducing sugars) was greater in chips prepared by conventional deep fat frying than in chips which were finished dehydrated in a microwave oven (Thomas et al., 1968). Boiled and baked potatoes generally have less acrylamide, whereas French fries and potato chips have higher acrylamide content (Friedman and Levin, 2008). When potatoes are cooked some loss of free amino acids and combined amino acids occurs. The losses are higher when low specific gravity potato tubers are cooked and they affect non-essential amino acids more than essential amino acids (Jaswal, 1973). Drying of potato before frying using microwave, hot-air treatment and baking can result in a significant reduction in oil content of different products (Fan *et al.*, 2005). Microwave cooking has gained considerable importance as an energy-saving, convenient, and time-saving cooking method. There is a delay in the development of rancidity in chips that have been microwave finished, resulting in a product with a longer shelf life (Thomas *et al.*, 1968). Earlier studies were conducted on the temperature and drying rate of microwave dried potato slices to examine the method of measuring the temperature during microwave drying of potato slice (Ji, 1992). Most reports indicated that microwave cooking resulted in higher moisture losses compared with conventional methods. Therefore, the present study was undertaken to study the effect of microwave power and baking time on quality of partially dried potato chips.

MATERIALS AND METHODS

Materials

Fresh and good quality potatoes free of any damage and spoilage were procured from local market and brought in laboratory for further processing.

Methods

1. Experimental procedure

Selected mature potatoes were washed and peeled by potato peeler. The peeled potatoes were trimmed to remove any discolored region or green area. It was sliced into thickness 1±10% mm, 2±10% mm, 3±10% mm and blanched in hot water + 2% NaCl solution at 72±5^{0}C for 6 min. and then slices were dipped in cold water for about the same length of time. The soaked sample was then drained and surface moisture was removed by blotting paper.

2. Drying

Potato slices were partially dried in cabinet tray dryer at 60^{0}C. The air flow rate in tray drier was 2.1m^3/min, thus reducing potato weight 20-30% of its initial value.

3. Microwave baking

Microwave oven was used for puffing and final finishing of potato chips. Partially dried potato slices were microwave baked at different microwave powers 60, 80 and 100 W and time intervals 40, 50 and 60sec, respectively. After baking the samples were cooled, packed and further qualitative analysis was conducted.

4. Analytical methods

4.1 Moisture content

The potato chips were ground with a mortar after microwave baking. Moisture content was determined using approximately 3.0g of the ground potato chips in a forced air oven at 105-110ºC until the weight constant (AOAC, 1984).The test was performed in triplicate and average value was taken. Moisture content was calculated on % wet basis.

4.2 Crude Fat content

Crude fat content of microwave baked potato chips was determined by Soxhlet extraction method with n-hexane for 6 hours (AOAC, 1984). The test was performed in triplicate.

4.3 Protein content

The protein content of microwave baked potato chips was determined by micro kjeldhal apparatus (AOAC, 1984). The test was performed in triplicate.

4.4 Sensory Analysis

Sensory analysis was conducted for all the samples. A panel of 10 judges was selected for sensory of microwave baked potato chips.The panelists marked their preference on a 9-Point Hedonic Scale (1 – Dislike extremely, 5 – Neither like nor dislike and 9 – Like extremely) in accordance with their opinion for color, taste, texture, appearance and overall acceptability.

4.5 Statistical Analysis

The experimental was conducted by adopting factorial design. The results were statistically analyzed by ANOVA. Statistical significance was judged with the help of 'F' (variance ratio). Calculated F value was compared with the table value of F at 5% level of significance.

RESULTS AND DISCUSSIONS

The results and discussion of the above experiments are given in the form of various characteristics of the baked potato chips

1. **Crude fat content**

The effect of microwave power and baking time on crude fat content of 1±10% mm, 2±10% mm and 3±10% mm thick potato chips vary from 0.25 to 0.42%, 0.20 to 0.44% and 0.20 to 0.44%. Fig. 1 represents the linear relationship between microwave power levels (60, 80 and 100 W) and crude fat content of 1±10% mm, 2±10% mm and 3±10% mm thick potato chips at different baking time (40, 50 and 60sec).

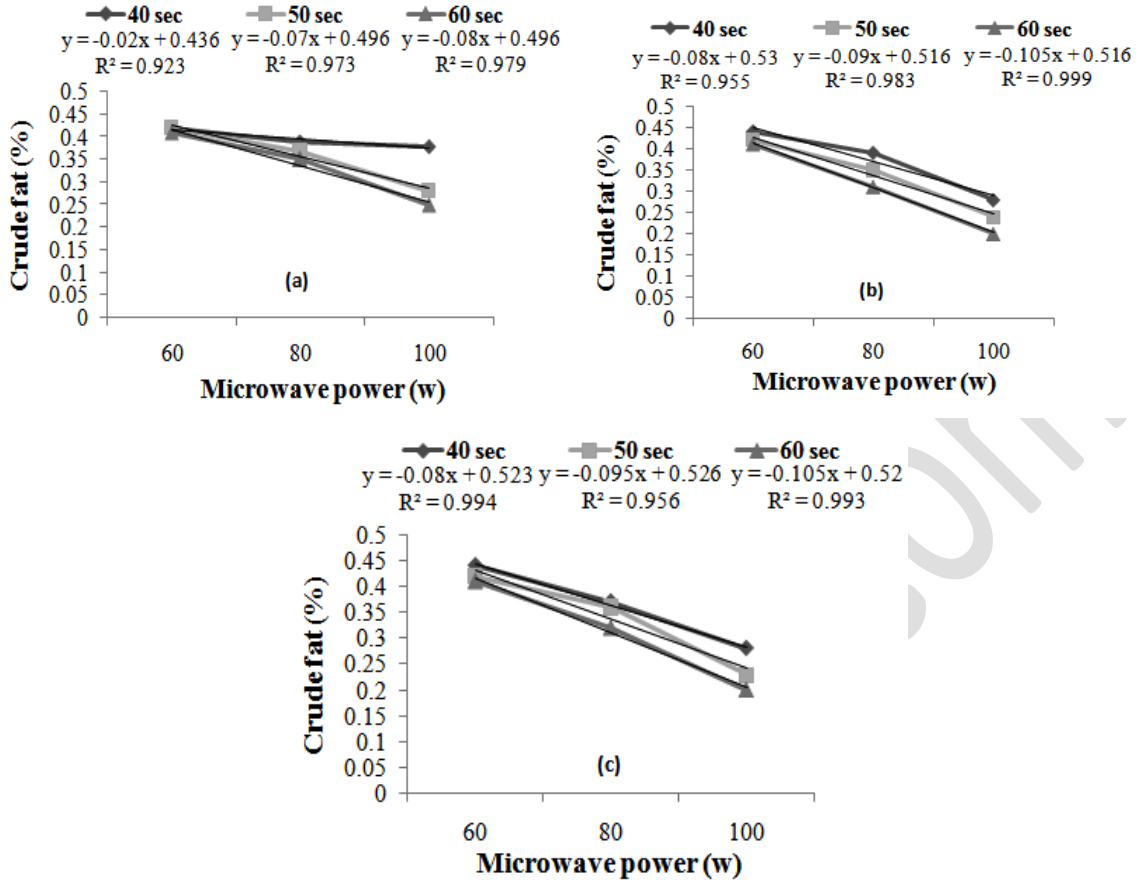

Fig. 1

(a) Effect of microwave power and time on crude fat content of potato chips (1±10%) mm.
(b) Effect of microwave power and time on crude fat content of potato chips (2±10%) mm.
(c) Effect of microwave power and time on crude fat content of potato chips (3±10%) mm.

Results showed that crude fat content decreases with increasing microwave power and baking time. The oil content of potatoes fried in microwave oven for all microwave powers were lower than the oil content of potatoes fried conventionally when sunflower oil or corn oil was used (Oztop *et al.*, 2007). Effect and interaction of microwave power and time was found to be significant ($p<0.05$) on crude fat content.

2. Protein content

Fig. 2 represents the linear relationship between microwave power levels (60, 80, 100 W) and protein content of 1±10% mm, 2±10% mm and 3±10% mm thick potato chips at different baking time (40, 50 and 60sec). Protein content of 1±10% mm, 2±10% mm and 3±10% mm thick potato chips vary from 3.50 to 4.40%, 3.70 to 4.50% and 3.90 to 4.60%. Results showed that protein content decreases with increase in microwave power and baking time because protein would be denatured with the modification in molecular structure upon heating. The degradation rate depends on the heating time and temperature. It has been shown that nutritive value of proteins in foods treated by conventional and microwave heating are comparable (Jaswal, 1973). The heat treatment of potatoes destined for cooking and baking

does not cause significant changes in total nitrogen & protein content (McCay *et al.*, 1987). Also the blanching of potatoes affects the protein content of final product. The microwave power and time significantly ($p<0.05$) affects the protein content of potato chips during microwave baking but their interaction has non-significant effect.

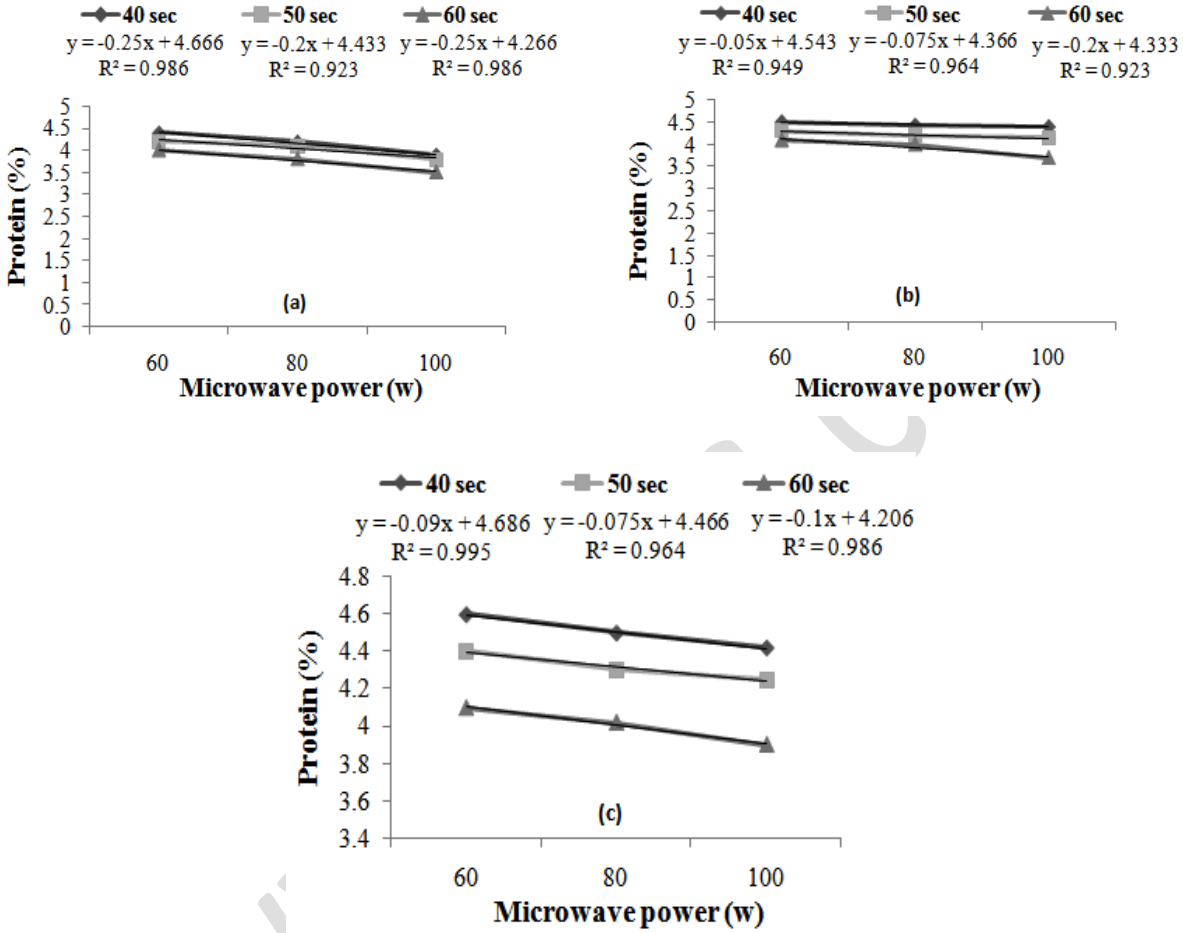

Fig. 2

(a) Effect of microwave power and time on protein content of potato chips (1±10%) mm.
(b) Effect of microwave power and time on protein content of potato chips (2±10%) mm.
(c) Effect of microwave power and time on protein content of potato chips (3±10%) mm.

3. Moisture content

The initial moisture content of potatoes was in the range of 80-82% on wet basis. Moisture content of microwave baked potato chips of 1±10% mm, 2±10% mm and 3±10% mm thickness was observed to be 1.40 to 2.20%, 1.60 to 2.40% and 1.70 to 2.50% (wet basis) at different microwave power levels (60, 80, 100 W) and baking time (40, 50 and 60sec). It was observed that the moisture content decreases with increasing microwave power and baking time. Various researchers have shown that microwave dried vegetables lost more moisture than conventionally dried ones (Sharma & Prasad, 2001; Sumnu *et al.*, 2005). The final moisture content of chips is critical as it not only influences the chips stability from microbial

storage but also contributes to the final crisp texture (Miranda and Aguilera, 2006). Effect of microwave power and baking time was found to be significant ($p<0.05$) but interaction of power and time was found to be non-significant. Linear relationship between microwave power levels and moisture content of potato chips at different time intervals was found (Fig. 3).

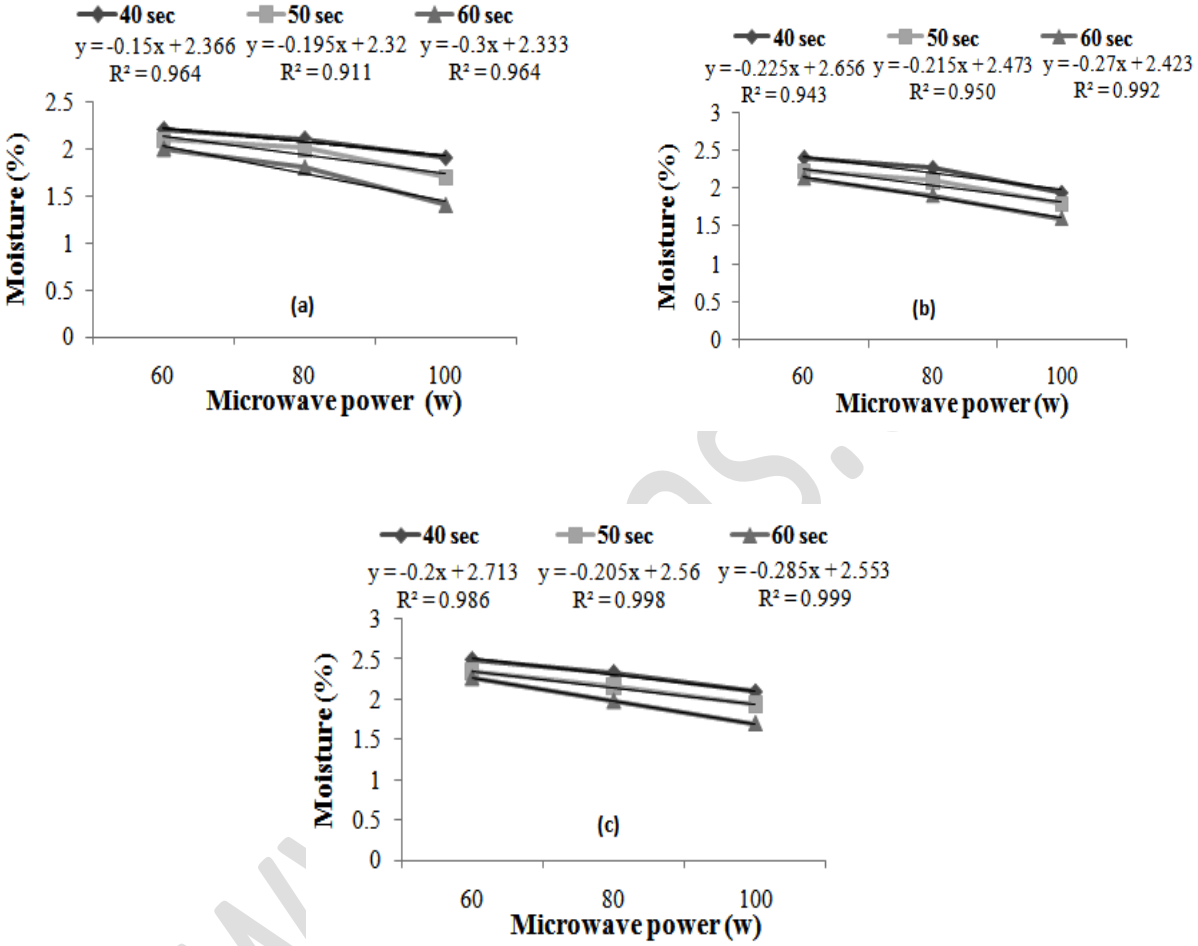

Fig. 3

(a) Effect of microwave power and time on moisture content of potato chips (1±10%) mm.
(b) Effect of microwave power and time on moisture content of potato chips (2±10%) mm.
(c) Effect of microwave power and time on moisture content of potato chips (3±10%) mm.

4. Sensory analysis

Sensory score in decreasing order was 3±10% mm > 2±10% mm > 1±10% mm potato chips. Sensory evaluation score for 3±10% mm baked potato chips is presented in Table 1. 3±10% mm chips were found to be most acceptable in terms of color, taste, texture, appearance and overall acceptability. Sample prepared at P=100W and T= 60sec was rated highest for taste (8.5) followed by the sample prepared at P=100W and T=50sec.

Table 1. Sensory evaluation sheet for (3±10%) mm thick microwave baked potato chips

Microwave power and time	Color	Taste	Texture	Appearance	OAA
60 W & 60 Sec	6.2±0.9	6.1±0.7	5±0.85	5±1	5.57±0.86
60 W & 50 Sec	5.5±0.8	5.2±0.76	3.5±0.97	3.3±1.12	4.38±0.91
60 W & 40 Sec	4.8±0.95	4.5±0.86	3±1.1	3.1±1.2	3.85±1
80 W & 60 Sec	8±0.5	7.5±0.78	7.2±0.89	7.1±0.9	7.45±0.77
80 W & 50 Sec	7.1±0.57	7.8±0.7	6.5±0.92	6.4±0.96	6.95±0.79
80 W & 40 Sec	6±0.65	7±0.6	5.5±1	5.5±1.1	6±0.84
100 W & 60 Sec	8±0.43	8.5±0.54	8±0.65	8.1±0.81	8.15±0.61
100 W & 50 Sec	7.5±0.62	8±0.58	7±0.74	7.1±0.88	7.4±0.71
100 W & 40 Sec	6.5±0.74	7±0.67	6±0.89	6±0.92	6.38±0.81

Data are mean ± SD (n=3), OAA- Overall acceptability

CONCLUSION

It can be concluded the fat and protein content of potato chips are affected by both microwave power and baking time. Although moisture content of potato chips showed non-significant effect by the interaction of power and time. Results obtained evident that higher the microwave power and baking time lower the moisture, crude fat and protein content of potato chips. Thin potato slices were characterized by high crude fat and low moisture content. Thickness more than 2 mm did not markedly affect the moisture, fat and protein content of potato chips. The treatment combination of 100 W and 60sec to 3-3.5 mm thick slices was found to be the best in terms of color, taste, texture, appearance and overall acceptability and for the production of low fat content potato chips. Microwave baking can be used as an alternate to deep fat frying.

REFERENCES

i. AOAC (1984). Official methods of analysis (14th Ed.). Washington, DC: Assoc. of Official Analytical Chemists. Food Eng. 89:24-12.
ii. Bunger A, Moyano P, Rioseco V (2003). NaCl soaking treatment for improving the quality of French-fried potatoes. Food Res. Inter. 36:161-166.
iii. Fan LP, Zhang M, Mujumdar AS (2005). Vacuum frying of carrot chips. Drying Technol. 23:645-656.
iv. Friedman M, Levin CE (2008). Review of methods for the reduction of dietary content & toxicity of Acrylamide. J. Agric. Food Chem. 56(15): 6113-6140.
v. Horton D and Sawyer RL (1985). The potato as a world food crop, with special reference to developing areas. In: Potato physiology. Li, P.H. Ed. Academic Press, Orlando 1-34.
vi. Jaswal AS (1973). Effects of various processing methods on free and bound amino acid contents of potatoes. American Potato Journal 50: 86-95.

vii. Ji DH, Kubota (1992). Studies on temperature and drying rate microwave dried potato slices. Journal of the Faculty of Applied Biological Sciences, Hiroshima University 121-126.
viii. Marwaha RS, Sandhu SK (2007). Potato flour processing. Ministry of Agriculture, Govt. of India 3(2):356-431.
ix. McCay CM, McCay JB, Smith O (1987). The nutritive value of potatoes In: Potato Processing, Talburt, W.F.; Smith, O. (Ed.) Van Nostrand Reinhold, New York 287-331.
x. Miranda ML, Aguilera JM (2006). Structure and texture properties of fried potato products. Food Rev. Int. 22:173-201.
xi. Oztop M, Sahin S, Sumnu G (2007). Optimization of microwave frying of potato slices by using Taguchi technique. J. Food Eng. 79:83-91.
xii. Sharma GP, Prasad S (2001). Drying of garlic (Allium sativum) cloves by microwave-hot air combination. J. Food Eng. 50:99-105.
xiii. Singh KK, Sahay KM, Dange Mohini M, Patel S (2007). Development of process technology for preparation of ready-to-eat puffed potato cubes. J. Agric. Eng. 44(2):241-249.
xiv. Sumnu G, Turabi E, Oztop M (2005). Drying of Carrots in microwave and halogen lamp microwave combination ovens. Lebensmittel-Wissenschaft und-Technologie 38: 549-553.
xv. Tamaki DS, Junichi H, Kazuhiko I (2003). Effect of low temperature storage on the quality of different processing cultivars of potato tubers. Graduate school of Agriculture, Hokkaido University. Food Preservation Sci. 29(5):878-922.
xvi. Thomas J. Fitzpatrick, William L. porter (1968). Microwave finishing of potato chips, effect on the amino acids and sugars. American J. Potato Research 45(3):103-110.
xvii. Woolfe JA (1986). The potato in the human diet. Cambridge University Press, Cambridge, UK 58-82.