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Development of banana chips using different drying methods and pretreatments

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Abstract
This study was done on "Development of banana chips using different drying methods and pretreatments". The production of banana chips is widespread activity in many banana-growing countries. Chips are an important ingredient in breakfast cereals. The chips are either fried in oil or dried. In the present study the effects of different pretreatments and temperatures on the drying characteristics of unripe banana chips were investigated control and per-treated (KMS and $NaSHO_4$). The samples were treated with KMS (Potassium metabisulfite) 1% and $NaSHO_4$ (Sodium bisulfate) 1% for 4 minutes and dried under tray dryer (60 °C, 70 °C and 80 °C), hot air oven (60 °C, 70 °C and 80 °C) and microwave oven (40, 60 and 80 watt).

Keywords: Banana, chips, potassium, magnesium, phosphorus, snack foods

Introduction
Banana (*Musa paradisiaca* L.) is the common name for herbaceous plants of the genus Musa. "banana" usually refers to soft, sweet "dessert" bananas. Banana plants are monocotyledonous perennial and important crop in the tropical and Sub tropical world regions (Valmgyor *et al*., 2000) [9], including dessert banana, plantain and cooking bananas. It contains 75% is water and 25% dry matter. The fruit is considered as an excellent source of Potassium, K (1491 mg/100gm). It has an appreciable quantity of Iron, Fe (1.15 mg/100gm), Magnesium, Mg (108 mg/100gm), Phosphorus, P (74 mg/100gm).The production of banana chips is widespread activity in many banana-growing countries. Chips are the most popular snakes in many fast food outlets in Bangladesh **(**Molla *et al*., 2009) [6, 7] and are the most popular plantain product in Nigeria (Onyejegbu and Olorunda, 1995). Chips can be preserved for a long time (months, possibly years) with adequate packaging and storage facilities. Chips are a ready-to-eat food and are a favourite among children and adults alike.

Materials and Methods
The study was undertaken in food analysis laboratory, Department of Agricultural Engineering and Food Technology, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut "Study on Drying Characteristics and Quality of Banana (*Musa paradisiaca* L.) chips using different drying methods" the experimental set up and the methodology for the production of control, KMS (Potassium metabisulfite) and $NaSHO_4$ (Sodium bisulfate) sample of whole, fresh unripe banana. Best quality dried product will be stored under ambient storage conditions and packaging materials. Quality parameters in the form of physico-chemical and nutrition will be monitored at an interval of one month. All the experiments were conducted in food analysis laboratory in the department of Agricultural Engineering and Food Technology.
Fresh good quality banana of Cavendish variety (unripe) were procured from the local market of Meerut. Care was taken to select firm and mature fruits without any defect on visual inspection. The selection of banana was unripe so as to get the best results and avoiding the further spoilage of the banana. The raw banana was peeled and cut into small pieces to the thickness of 8-12 mm. size and then dipped in the solution using tap water for 4 minutes and then rinsed by tap water in order to remove the rest of chemical solution from slice surface. During drying, the hot air oven temperatures, tray drying temperatures used will be 60 °C, 70 °C and 80 °C and microwave oven temperatures used will be 40, 60 and 80 W. During drying, the range of air velocity will be 0.8-1.0 m/s.

Different pre-treatment methods have been developed for fruits drying, among which are lemon which are lemon juice, salt solution, honey dip, ascorbic acid, sulfuring, osmotic pre-treatment, and blanching (Karim, 2005) [3]. Pre-treatment usually performed between preparation and subsequent processing. The raw banana was peeled and cut into small pieces to the thickness of 8-12 mm. size and then dipped in the solution using tap water for 4 minutes and then rinsed by tap water in order to remove the rest of chemical solution from slice surface. Two chemicals solution are used in pre-treatment of banana chips was KMS (Potassium metabisulfite) 1%, NaSHO4 (Sodium bisulfate) 1%.

One segment of the present study relates to drying. Before drying, some physical and chemical treatments will be given to the samples. Control samples will be also taken.

The study of drying behavior of different materials has been the subject of interest for various investigators on both theoretical and practical grounds. In the course of studies conducted regarding the drying behavior of various agricultural products. During drying, the hot air oven temperatures, tray drying temperatures used will be 60 °C, 70 °C and 80 °C, and microwave oven temperatures used will be 40, 60 and 80 W. During drying, the range of air velocity will be 0.8-1.0 m/s.

Preparation of Banana chips

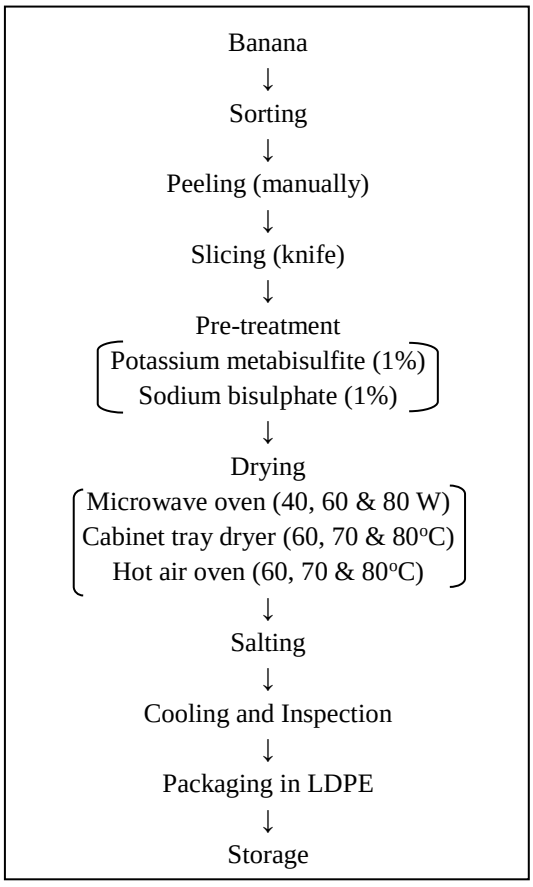

Fig 1: Flow chart for Preparation of Banana chips

Cabinet Tray Dryer

Banana samples with two pre-treatment in addition to control samples were dried by cabinet tray dryer convectional oven at three temperatures (60, 70 & 80 ^{0}C). Moisture loss was recorded each 30 min intervals during drying for determination of drying curves by removing sample from drier, cooling and weighting until safe moisture content was reached, cooled, packed in LDPE bags and stored in cool and dark place before quality factors determination. A Cabinet type mechanical tray dryer (Industrial Dryer, M/s Navyug Udhyog Pvt. Ltd Ambala) was used to conduct drying experiment. The dryer had drying chamber heating unit and a fan. Drying chamber was an insulated box with a single door opening at front. Ten aluminum tray were placed in drying chamber. Six heating units were provide to increase the temperature inside the drying chamber. The heating air was circulated inside the cabinet with the help of circulating fan.

Microwave Oven

Banana slices with two pre-treatment in addition to control samples were dried in microwave oven at three power intensity (40, 60 & 80 W). Sample were removed in each 1 min intervals from dryer, cooled, weighted and returned dryer periodically until reached to the final safe moisture content. The samples were distribution into dryer symmetrically for uniform microwave energy distribution in oven. When sample reached to the final safe moisture content, cooled, packed in LDPE bags and stored in cool and dark place before quality factors determination.

Hot Air Oven

Banana samples with two pre-treatment in addition to control samples were dried by hot air oven conventional oven at three temperatures (60, 70 & 80 ^{0}C). Moisture loss was recorded each 30 min intervals during drying for determination of drying curves by removing sample from drier, cooling and weighting until safe moisture content was reached, cooled, packed in LDPE bags and stored in cool and dark place before quality factors determination. Hot air oven (Instron, IN-301 Model) is a double walled chamber of size 78×27×116 (cm). Outer chamber is made of stainless steel. Hot air ovens are electrical devices used in sterilization.

Results and Discussion

Control and per-treated (KMS & NaSHO4) samples dried and packed in LDPE bags and stored under ambient storage conditions. Quality parameters in the form of physico-chemical and sensory will be monitored at an interval of 15 days. According to Katekawa and Silva (2007) [5], drying of bananas is used not only for preservation, but also to aggregate value to the product, as in chips. Likewise, Janjai *et al*. (2009) [1] also observed that banana is dried not only for preservation purposes, but also for modification of the taste, flavor and texture to meet consumer preferences and to increase the market value of the product. All the experiments were conducted in food analysis laboratory in the department of Agricultural Engineering and Food Technology. The banana slices of thickness 8-12 mm size and were treated with KMS (Potassium metabisulfite) 1% and NaSHO4 (Sodium bisulfate) 1% for 4 minutes and then rinsed by tap water in order to remove the rest of chemical solution from slice surface and dried under tray dryer (60 °C, 70 °C & 80 °C), hot air oven (60 °C, 70 °C & 80 °C) and microwave oven (40, 60 & 80 watt). On the basis of the findings of the present investigations, The moisture content was decreased with increase in temperature. Moisture content of KMS treated banana slice was found to be lowest in cabinet tray dryer at 80 ^{0}C. Among the hot air oven and microwave oven drying respective of pre-treatment. KMS treated banana slice took minimum time to get the final moisture content within 7 min of microwave oven drying at 80 watt. Constant rate of drying was absent throughout the process. Drying rate was found

superior for KMS treated banana slices in microwave oven at 80 watt as compared NaHSO4 treated and controlled banana slice. The drying rate of KMS treated banana slices was found to be higest in cabinet tray dryer at 70 ^{0}C as compared to NaHSO4 treated and controlled banana slice. Drying rate was found to be highest for KMS treated banana slices dried in hot air oven at 80 ^{0}C as compared to NaHSO4 treated and controlled banana slice. Major drying took place in falling rate period. Moisture ratio initially decreased very rapidly and in later stage decreased at slower rate. NaHSO4 treated banana chips gain least moisture as compared to KMS treated and controlled banana chips after 45 days of storage dried at 80^{0}C in hot air oven. Controlled banana chips gain highest Moisture dried at 60 ^{0}C in hot air oven after 45 days of storage period. KMS treated banana chips, rated highest score for color and taste dried at 70 ^{0}C in cabinet tray dryer. Whereas KMS treated banana chips, highest score for texture dried at 80 ^{0}C in tray dryer after 45 days of storage. KMS treated banana chips, rated highest score for texture and taste dried at 40 watt in microwave oven. Whereas KMS treated banana chips, highest score for color dried at 60 watt in microwave oven after 45 days of storage. KMS treated banana chips, rated highest score for color dried at 70 ^{0}C in hot air oven. Whereas KMS treated banana chips, rated highest score for taste and texture dried at 60 ^{0}C and 80 ^{0}C in hot air oven after 45 days of storage. Overall acceptability of KMS treated banana chips dried in cabinet tray dryer at (70 ^{0}C), microwave oven (60watt), and hot air oven (70 ^{0}C), were found superior over the others treated and controlled banana chips after 45 days of storage. The present study revealed that overall sensory quality of dried banana chips depend significantly upon drying methods, pre-treatments, storage period and packaging material. Thus from present studies, it can be concluded that the banana chips pre-treated with KMS solution dried in cabinet tray dried at (80 ^{0}C) and microwave oven at (80watt) exhibited best results over the drying methods. Another pre-treatment i.e. of NaHSO4 solution and drying method i.e. hot air oven drying was also found to be good during this present study. Therefore, above pre-treatment and drying method could be recommended for drying of banana slices.

Table 1: Effect of treatments on moisture content at 60 ^{0}C, 70 ^{0}C and 80 ^{0}C of banana chips in cabinet tray dryer.

	60^{0}C			**70^{0}C**			**80^{0}C**		
Storage days	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**
0	7.10±3	6.56±3	6.12±4	6.70±3	6.45±3	6.06±3	6.30±2	6.12±2	6.02±3
15	8.30±3	7.39±3	7.24±3	7.90±3	7.49±4	7.25±2	7.50±3	6.76±2	6.53±3
30	8.68±3	7.86±3	7.19±2	8.10±3	7.98±4	7.39±3	7.98±3	7.29±3	7.18±2
45	8.87±2	8.43±3	8.00±3	8.65±2	8.39±3	7.98±3	8.43±3	7.88±3	7.65±2
CD	N.S.			0.702			0.802		

*CD- critical differene *N.S.-non significance

Table 2: Effect of treatments on moisture content at 40, 60, and 80 watts of banana chips in microwave oven.

	40 watt			**60 watt**			**80 watt**		
Storage days	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**
0	7.10±3	6.56±3	6.11±0.04	6.62±0.03	6.32±0.04	6.02±0.02	6.12±0.02	6.02±0.02	5.96±0.02
15	8.30±3	7.39±3	7.19±0.03	7.89±0.01	7.56±0.01	7.26±0.03	7.47±0.02	6.68±0.03	6.48±0.02
30	8.68±3	7.86±3	7.17±0.03	8.24±0.04	7.92±0.03	7.31±0.02	7.91±0.03	7.23±0.02	7.16±0.02
45	8.87±2	8.43±3	8.19±0.05	8.74±0.03	8.30±0.02	7.62±0.02	8.39±0.03	7.83±0.02	7.59±0.03
CD	N.S.			0.755			0.791		

*CD- critical differene *N.S.-non significance

Table 3: Effect of treatments on moisture content at 60 ^{0}C, 70 ^{0}C and 80 ^{0}C of banana chips in hot air oven.

	60 ^{0}C			**70 ^{0}C**			**80 ^{0}C**		
Storage days	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**	**T_0 (controlled)**	**T_1 (Potassium metabisulphite)**	**T_2 (Sodium bisulfate)**
0	7.12±0.03	6.59±0.03	6.35±0.02	6.74±0.3	6.47±0.02	6.09±0.3	6.35±0.4	6.13±0.03	6.05±0.04
15	8.33±0.02	7.42±0.02	7.29±0.03	7.95±0.2	7.51±0.03	7.28±0.2	7.54±0.5	6.78±0.03	6.55±0.03
30	8.70±0.03	7.89±0.02	7.67±0.03	8.53±0.2	8.23±0.03	7.90±0.1	7.99±0.2	7.31±0.02	7.21±0.03
45	8.91±0.02	8.48±0.03	8.10±0.02	8.67±0.3	8.49±0.02	8.10±0.3	8.32±0.3	7.81±0.03	7.18±0.02
CD	1.032			0.667			0.808		

*CD- critical differene, *N.S.-non significance

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