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Study on effect of quality of green banana flour using different drying techniques

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Abstract
The study was to examine the effect of quality of green banana flour using different drying techniques. The drying techniques used in the current study were fluidized bed drying, solar drying, sun drying, oven drying, and osmotic drying at different concentrations (30, 40 and 50%). Bananas were sliced according to 3mm and 5mm thickness using vernier callipers and are steamed followed by chemical pre treatment was given with 0.25% KMS and 1% Calcium chloride. The slices were dried and ground to fine powder form. Then Banana flour was analysed and comparative study performed for different drying techniques. The responses were studied for proximate analysis and physical analysis, in former analysis moisture content, ash, protein, starch, total phenols, total amino acids and vitamin-c were estimated, and the results varied between 3.3 to 5.8%, 1.5 to 2.2%, 2.9 to 7.95%, 46.05 to 50.57 mg/100g, 0.96 to 1.83 mg GAE /100 g, 0.22 to 0.85%, 1.08 to 5.13 respectively. The results for physical analysis was carried out for the calculation of solubility parameters and bulk density. Conducted analysis on solubility parameters confirms that the increase in temperature leads to the decrease in solubility.

Keywords: Green banana flour, different drying techniques and proximate analysis

Introduction
The word "banana" is a general term embracing a number of species or hybrids in the genus *Musa* of the family *Musaceae*. Bananas and plantains (cultivars of banana having firmer and starchier fruit) are grown today in every humid tropical region and constitute the second largest fruit crop following the citrus fruits of the world.
The large quantity of unmarketable bananas available in all banana growing regions of India are wasted due to improper postharvest handling and lack of processing technology for value addition. The waste due to surplus banana production can be minimized by preparing banana chips and banana flour from the excess banana. Banana flour is most widely used as raw material for other value added products from banana. It contributes to the flavour of widely food products and its functional properties are also good value.
Dried products are subject to contamination by extraneous materials such as sand, stones, soils, tree leaves and incursion by rodents, insects, animal excreta and various forms of micro-organisms. In view of this, efforts were made to improve traditional drying methods have been going on. Adding to that discoloration during preparation and drying commonly called "browning" is caused by chemical or biochemical reactions or over heating due to difficulties in controlling the drying conditions notably temperature and time (Anon, 1993) [2] are also some of the problems associated with drying.
In contrast currently the market prefers high quality dried products with good reconstitution properties and excellent sensory attributes. To combat all the factors associated with declining quality of banana, the present study was carried out to investigate the effect of different drying methods on the quality of banana flour.

Materials and Methods
Materials required
Green bananas, Potassium meta bi sulphite, Calcium chloride, Water, Sugar, Trays, Knife, and Grinder. Potassium meta bisulphite was mainly used for preservative and prevent the browning reaction. Calcium chloride is mainly used for preservative and act as firming agent.

Equipment required
Thermo meter, Venire callipers, Solar dryer, Fluidized bed dryer, Hot air oven, Weighing balance

Preparation of green banana flour by different dryers
Fresh green bananas washed with water were subjected to steaming for 15 min at 82 ℃. Bananas were peeled and cut into pieces for 3 mm thickness (5 mm for additional solar drying treatment) and pre-treated with 0.25% KMS and 1% Calcium chloride for 15min are used for different drying processes.
Pieces were dried for 2 hours at 60 °C in fluidized bed dryer, 12hours at 60 °C in oven dryer, 48 hours in solar dryer, 24 hours in sun drying. After drying ground all of them into flour using grinder. Banana flour was sieved using 150 mm sieve and packed into different zip lock pouches and then stored at room temperature separately for further analysis.

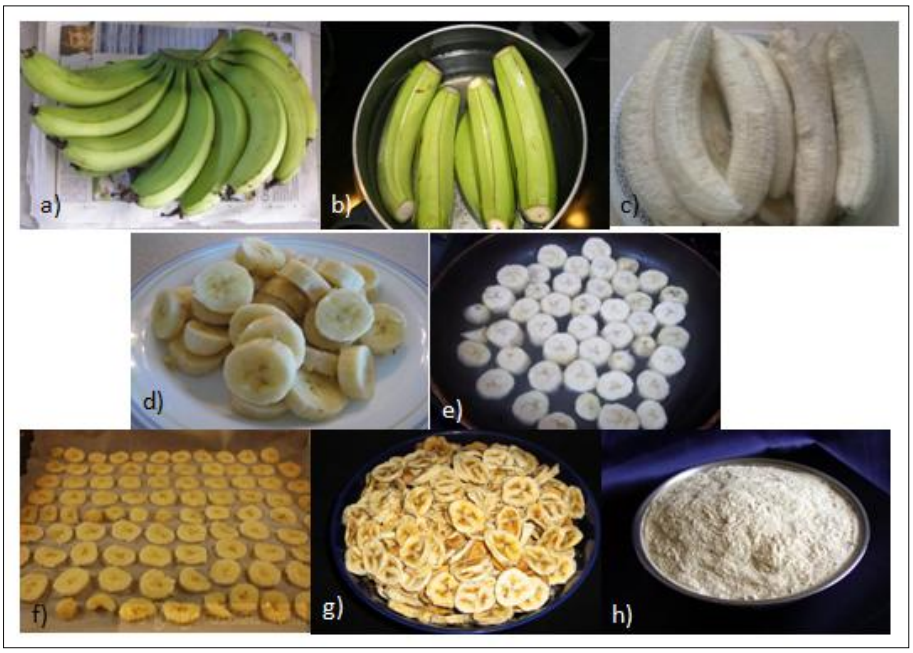

Fig 1: Processing steps of banana flour: a) Green Banana, b) Bananas after subjected to steaming, c) Bananas after peeling, d) Cutting the peeled pieces, e) Pre-treatment with 0.25%KMS+1%calcium chloride, f) Pieces exposed to drying, g) Pieces in dried form, h) Green banana flour.

Table 1: Different drying technique

S. No.	sample	Drying type	Slice thickness	Temperature Maintained	Time interval
1.	Sample A	Solar drying	5mm	42 °C	48 hours
2.	Sample B	Solar drying	3mm	42 °C	48 hours
3.	Sample C	Sun drying	3mm	37°C	48 hours
4.	Sample D	Oven drying	3mm	60°C	12 hours
5.	Sample E	Fluidized bed dryer	3mm	60 °C	2 hours
6.	Sample F	Osmotic drying (30%)	3mm	60°C	12 hours
7.	Sample G	Osmotic drying (40%)	3mm	60°C	12 hours
8.	Sample H	Osmotic drying (50%)	3mm	60°C	12 hours

Preparation of green banana flour by osmotic dehydration
Sugar solution is prepared at different concentrations using 30, 40 and 50%. Slices of pre-treated banana pieces having 3mm thickness were dipped in 100 ml of 30, 40 and 50% of sucrose solution; slices were kept immersed in solution for the duration of 15 minutes and then removed. Procedure was repeated for solution kept at 45 and 65 °C temperature. The percent weight reduction was calculated for each observation. Then the solution was drained away and pieces were taken out. Banana pieces after treatment dried in an oven dryer for 12hours at 60 °C. After drying ground all of them into flour using grinder. Banana flour was sieved using 150 mm sieve and packed into different zip lock pouches and then stored at room temperature separately for further analysis.

Analytical procedures for banana flour
Proximate analysis
The moisture content was estimated as per standard ISI 0484.1983 specification by oven method. Ash content was determined by incineration at 550 ˚C, following the AOAC method, Ref. 140.06 (AOAC, 1980) [3]. The total nitrogen content was detected using the Kjeldahl method Ref. 932.03 (AOAC, 1990) [6]. The percentages of nitrogen were transformed into protein content by multiplying by a conversion factor of 6.25. Starch content was determined by anthrone method (Hansen J, Møller IB, 1975) [10].Vitamin C content of the samples was determined. The estimation of energy by isothermal oxygen bomb colorimeter.
Total phenolic contents of fruit and vegetable samples were determined by the Folin–Ciocalteu method (Meda, Lamien, Romito, Millogo, & Nacoulma, 2005) [11]. Briefly, aliquots of 0.1 g lyophilized powder of fruit and vegetable samples were, respectively, dissolved in 1 ml deionized water. This solution (0.1 ml) was mixed with 2.8 ml of deionized water, 2 ml of 2% sodium carbonate (Na2CO3), and 0.1 ml of 50% Folin–Ciocalteau reagent. After incubation at room temperature for 30 min, the absorbance of the reaction mixture absorbance was measured at 750 nm against a deionized water blank on a

spectrophotometer (Hitachi, Model 100-20). Gallic acid (GA) was chosen as a standard. Using a seven point standard curve (0–200 mg/l), the levels of total phenolic contents in fruits and vegetables were determined in triplicate, respectively. The data were expressed as milligram gallic acid equivalents (GAE)/g lyophilized powder. Finally, the data were converted to milligram gallic acid equivalents (GAE)/ 100 g fresh matter of fruit or vegetables based on the moisture contents of lyophilized powder and fresh fruit and vegetable materials.
Free Amino acids were determined using.

Physical analysis
Solubility was determined by the method described of Leach *et al*. One gram of sample was weighed into a 100ml conical flask; 15ml of distilled water was added and mixed gently at low speed for 5mins. The slurry was heated in a thermostatic water bath (THELCO model 83, USA) AT 40mins. During heating, the slurry was stirred gently to prevent lumps forming in the starch. The supernatant was decanted immediately into a pre – weighed can and dried at 100 °C to constant weight. The weight of the sediment was taken and recorded.

$$\text{Solubility index (\%)} = \left(\frac{\text{Weight of Soluble}}{\text{Weight of Sample}} \times 100\right)$$

Bulk density was determined using the method described by Wang and Kinssela. Samples (10g) were weighed into a 50ml graduated measuring cylinder. The sample was packed by gently tapping the cylinder on the bench top for several times until there was no more decrease in volume. The volume of the compacted sample was recorded and the bulk density was calculated as follows

$$\text{Bulk density } \left(\frac{g}{ml}\right) = \left(\frac{\text{Weight of sample}}{\text{Volume after tapping}}\right)$$

Results and Discussion
Proximate analysis
Estimation of moisture content
The moisture content of prepared sample is found to be higher in sample F (5.85%) by other sample A(3.3%), sample B(4.53%),sample C(4.43%),sample D (3.46%),sample E(4.76%) moisture content is higher in sample F compared to other samples.

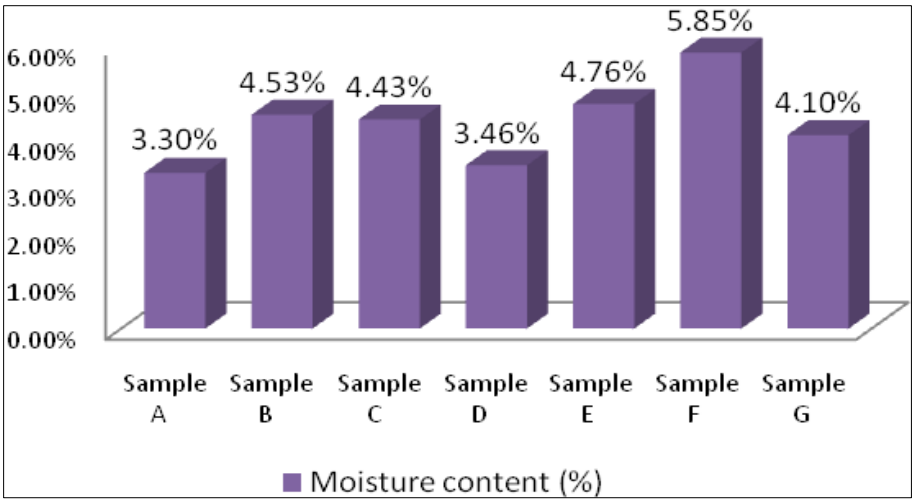

Fig 2: Analysis of moisture content (%)

Estimation of Ash content
The ash content of prepared sample is found to be higher in sample A (2.2%), followed by others sample B (2.0%), sample C (1.9%), sample D (1.8%), sample E (1.5%), sample F (1.75%), sample G (2%), sample H (2.1%) so, the results shows that ash is higher in sample A as compare to other samples.

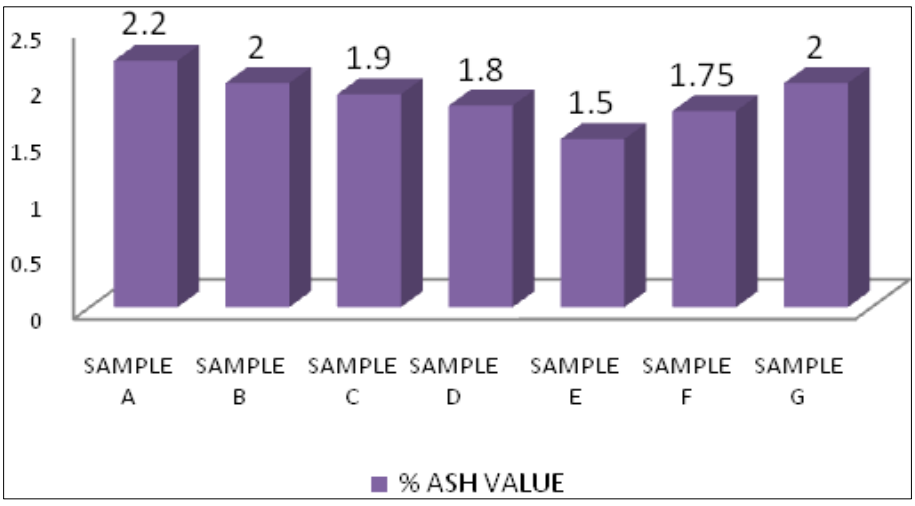

Fig 3: Analysis of ash (%)

Estimation of protein content

The protein content was found to be highest in sample E (5.75) followed by other samples sample A (5), sample B(3.8), sample D (3.75),sample G (3.2), sample H (3.2),sample F (3.1), sample C(2.9).

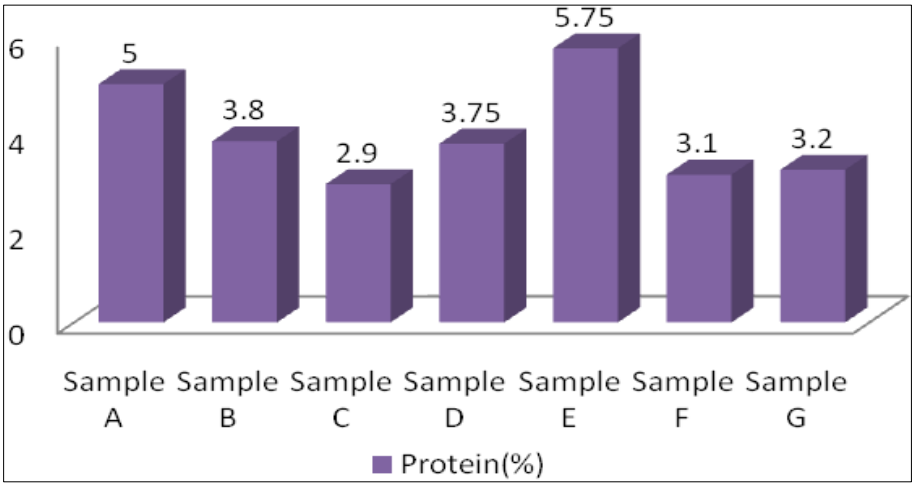

Fig 5.3: Analysis of protein (%)

Estimation of vitamin-C

The vitamin C content was found to be higher in sample E (5.13) followed by other samples sample A (2.16), sample H (2.07), sample G (1.98),sample D (1.89), sample F (1.70),sample C (1.70), sample B (1.08).

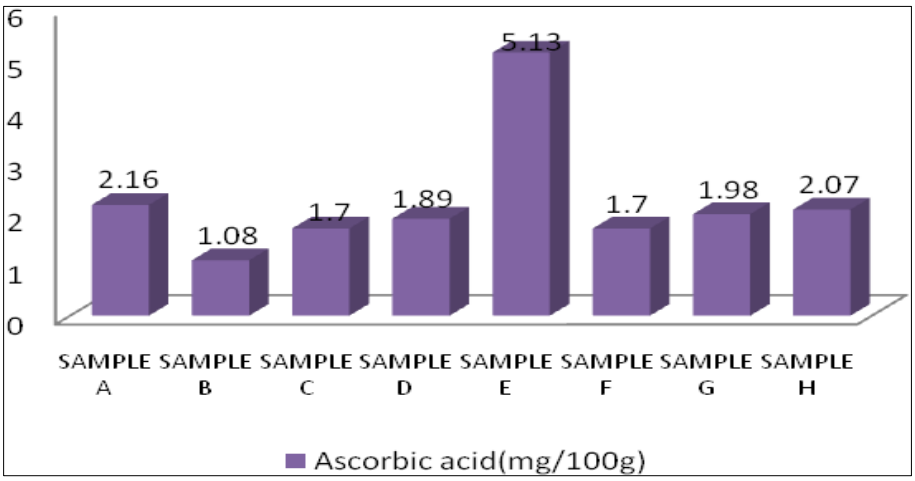

Fig 5.4: Analysis of vitamin-c

Estimation of Starch

The starch content was found to be higher in sample E (50.57), followed by other samples sample D (49.47), sample F (48.96), sample G (48.93), sample H (48.23), sample A (48.37), sample B (47), sample C (46.05).

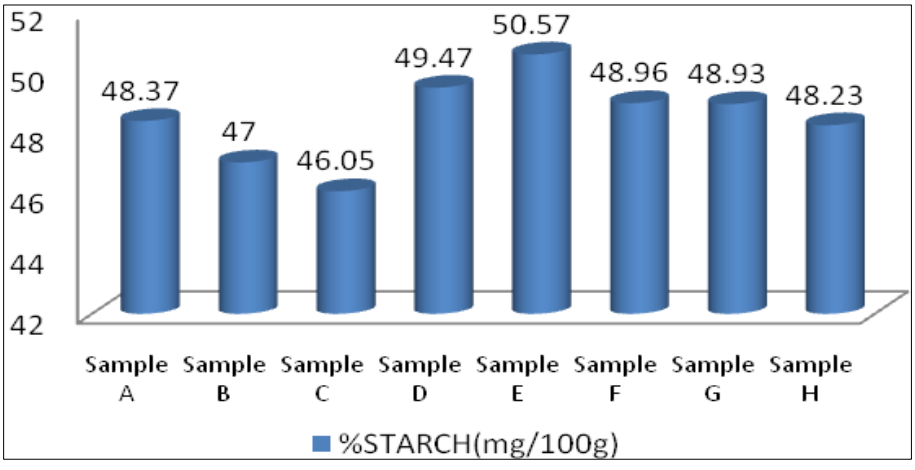

Fig 5.5: Analysis of starch

Estimation of free amino acids

The free amino acids content was found to be higher in sample E (0.85), followed by other samples sample D (0.38), sample H (0.37), sample G (0.35), sample F (0.31), sample A (0.25), sample C (0.24), sample B (0.22).

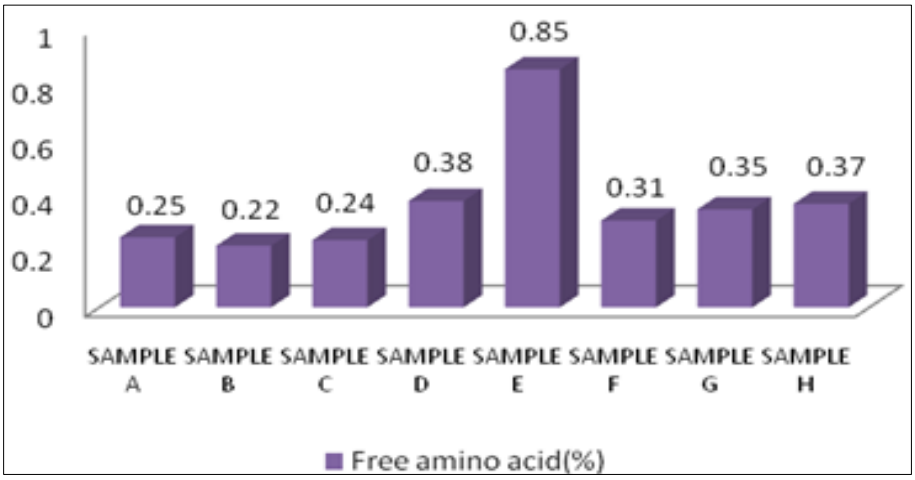

Fig 5.6: Analysis of free amino acids

Estimation of total phenols

The total phenols was found to be higher in sample E (1.83), followed by other samples sample D (1.16), sample F (1.15), sample G (1.13), sample H (1.12), sample A (1.09), sample B (0.98), sample C (0.96).

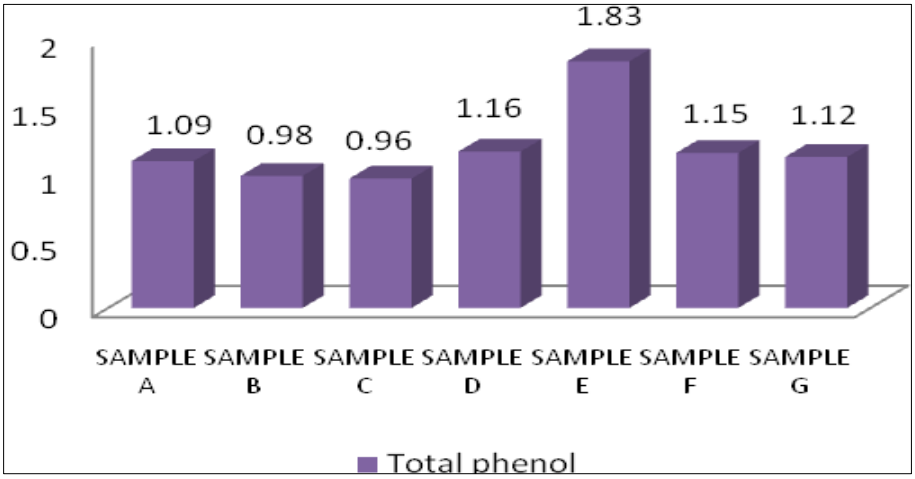

Fig 5.7: Analysis of total phenols

Estimation of energy

The energy found in the sample to be higher in the sample B (5329.2), followed by other samples sample F (3996), sample A (3324.1), sample H (2997), sample E(2321.86), sample G(1996.1), sample D (1996), sample C (1060.4).

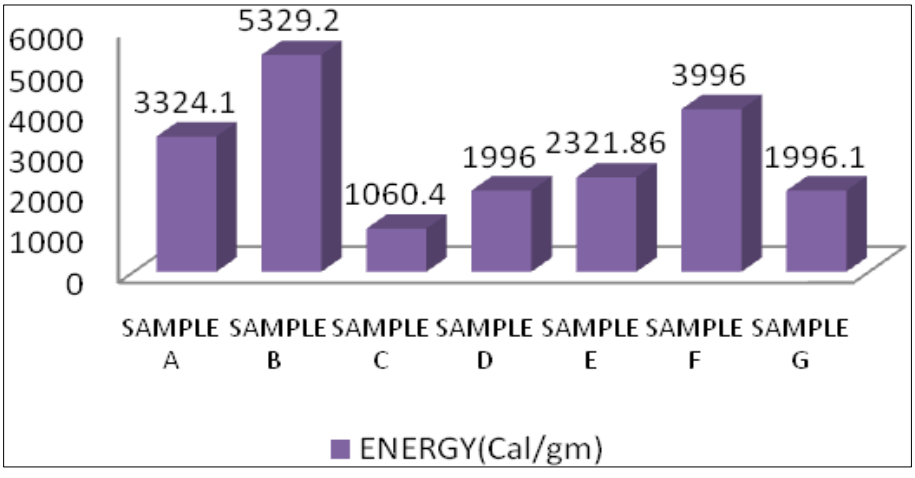

Fig 5: Analysis of energy

Physical Analysis

Solubility: The solubility higher in the sample B at50 °C than other samples temperature increases solubility decreases.

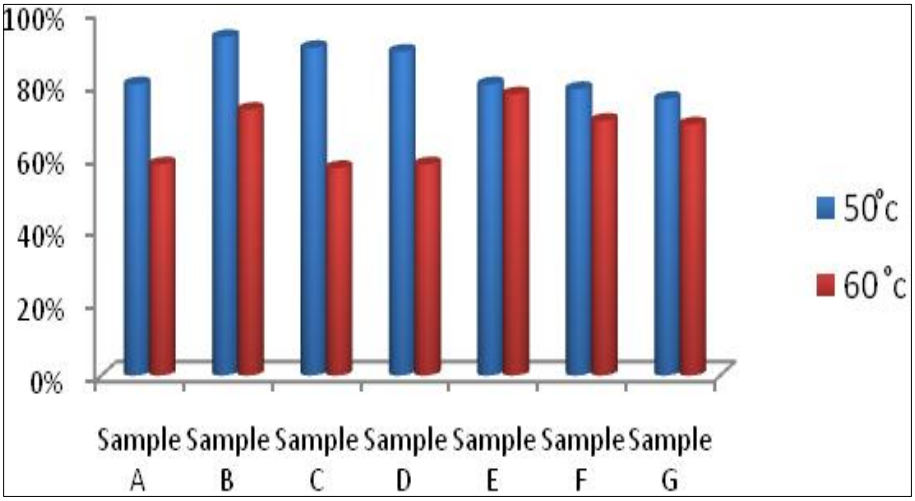

Fig 5.9: Analysis of solubility

5.2.2. Density

The density is found to be higher in sample E (0.68), followed by other samples sample D (0.67), sample G (0.67), sample A (0.66), sample H (0.66), sample C (0.66), sample F (0.66), sample B (0.65).

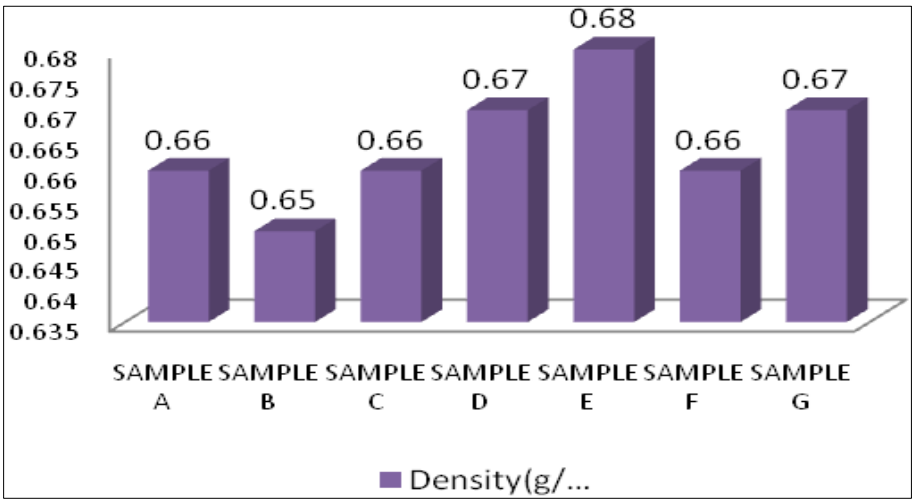

Fig 5.10: Analysis of density

Conclusion

The Research work carried out as per the above presented theme focuses on the drying techniques and processing of Green banana flour based on the particular drying technology involved. Basically the processed Green banana flour is a non-perishable product. The non perishable products always possess moisture content below 13% and water activity is always less than 0.01. Hence the negative indication of microbial, bacterial or fungal growth is observed. So it was confirmed that the processed green banana flour was under safer limits without microbial attack even without microbial analysis. The overall assessment of very good quality of Green banana flour was obtained by fluidized bed drying maintained at 60 (3 mm thickness of banana slices) It was concluded that solubility parameters of Green banana flour samples showed inverse relation with temperature (solubility decreases with increase in temperature).

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