Comparative Studies and Quality Evaluation of Beetroot Powder by Different Drying Methods

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Abstract **- Beetroot (Beta vulgaris) is a root vegetable also known as red beet, table beet, garden beet, or just beet and it is normally used as natural food colorants in food industry , beetroots are a great source of fiber , folate (vitamin B9), manganese, potassium, iron, and vitamin C.. The objectives of present research is to study the influence of drying on quality of beetroot slices, the drying characteristics of beetroot slices, the Physico-chemical properties of beet root powder, the nutritional composition of beetroot powder, the comparison between different dryers and best dryer is selected for product development and develop the product (soup) from beet root powder, to conduct the sensory properties of beetroot powder, . After the dehydration of beetroot slices in three different types of dryers (Tray 40ºC, Tray 50ºC Tray 60ºC, Sun and Solar). Moisture content was lower in Tray dried sample at 60ºC but colour and texture was not acceptable when compared to the solar dried sample. Dry matter content was higher in solar dried sample i.e., 93.52% when compared to other samples. Ash content (8.06%) and crude fibre content (2.78g) was higher in solar dried sample. Solar dried sample is best for product development. 10% beetroot powder formulation (solar dried) is acceptable by the sensory evaluation. The solar dried beetroot sample is best for product development (soup).**

Index Terms **- Beetroot, Solar Drying, Sun Drying and Tray Drying.**

I.INTRODUCTION

Beetroot is one of the richest dietary sources of antioxidants and naturally occurring nitrates. The nitrates in beetroot improve blood flow through the body including the brain, heart and muscles. It increases a molecule in the blood vessels called nitric oxide which helps open up the vessels and allows more oxygen flow, it also lowers blood pressure and decreases the incidence of cardiovascular disease. A number of studies have reported beetroot as a dietary inorganic nitrate with a potential for reducing blood pressure in humans. Coles & Clifton also reported that after consumption of beetroot on a low nitrate diet, it may lower blood pressure and therefore reduce the risk of cardiovascular event. Dietary nitrate supplementation has also been reported to reduce the oxygen cost of low intensity exercise in humans.

1.1 Soup

Soup is a primarily liquid food, generally served warm or hot (but may be cool or cold), that is made by combining ingredients of meat or vegetables with stock, milk, or water. Hot soups are additionally characterized by boiling solid ingredients in liquids in a pot until the flavors are extracted, forming a broth. Soups are similar to stews, and in some cases there may not be a clear distinction between the two; however, soups generally have more liquid (broth) than stews.

1.2 Soups are classified into two main groups:

(1) Clear soups and (2).Thick soups.

Clear soups are bouillon and consommé. Thick soups are classified depending upon the type of thickening agent used. Purees are vegetable soups thickened with starch; bisques are made from puree shellfish or vegetables thickened with cream, cream soups may be thickened with bechamel sauce and veloutes are thickened with eggs, butter, and cream. Other ingredients commonly used to thicken soups and broths include rice, lentils, flour, and grains; many

popular soups also include pumpkin, carrots, potatoes, pig's trotters and bird's nests.
Other types of soup include fruit soups, dessert soups, pulse soups like split pea, cold soups and other styles The main objectives of this study was the influence of drying on quality of beetroot slices, the drying characteristics of beetroot slices, the Physico-chemical properties of beetroot powder, the nutritional composition of beetroot powder (before and after drying), the comparison between different dryers(Tray, Sun and Solar) and best dryer is selected for product development and To develop the product (soup) from beet root powder and study the sensory properties of beetroot powder soup.

II. MATERIALS AND METHODS

Raw Materials: Beetroot
Equipment: The weighing balances, hot air oven, solar drier, muffle furnace, refractometer, Spectrophotometer, Atomic absorption spectroscopy.
Methods

Sample preparation: -
Beetroots were washed, cleaned from dirt, peeled using knife and sliced to required size of 2 mm thickness and 2.5 cm diameter. The sliced beetroot was then weighed to 100 gm to standardize the amount required for various treatments of the study.

Methods for Drying:
A. Tray drying:
The dryer was pre-heated to required temperature and then the samples of 20g each were spread in thin layers on the trays. Once the drying process started, the weights of the sample were collected at every 30 min until a constant weight was reached. The process was done by taking sample of 20g at a temperature of 40ºC, 50ºC and 60°C.

B. Sun Drying:
Spread the grains in thin layers, ideally 2−4 cm but less than 5 cm. For faster drying, place the grains in well-aerated or windy areas. Spread grains frequently and note readings (at least every 60 minutes). Monitor grain temperature and MC using thermometers and moisture meters.

C. Soar drying:
The sample (beetroot slices) were spread evenly on the drying tray placed on the shelf of the drying cabinet. Each 30 min interval the samples were weighed. When the desired moisture is reached product was removed from the cabinet The resulted moisture content was reported on a % wet or dry basis The drying air temperature was analyzed using a thermometer

D. Physico Chemical Properties a. Size:
To determine the length vernier calipers is used. The beetroot slice is fixed length wise between the jaws and the vernier calipers. Then the reading of main scale and vernier scale and also least count are noted.
Where,
L=M.S.R+(L.C×V.S.R) (L.C=0.02mm) M.S.R = Main scale reading
V.S.R = Vernier scale reading
L.C = Least Count
To determine the breadth of the slice, screw guage is used. The slice is fixed breadth wise between the jaws of screw guage. The reading of head scale and pitch scale and also least count are noted. Then, breadth of the grain is calculated by
B=H.S.R+(L.C×P.S.R) (L.C=0.01mm)
HSR= Head scale reading
PSR= Pitch scale Reading
L.C = Least Count

b. Moisture content:
Apparatus: Petri plates, Desiccators
Procedure:
Weigh accurately 5g of sample when the oven attains 105ºC then the dishes have been placed. Remove the dishes at regular intervals and cool in the desiccators. Weights were noted until constant weights are obtained.

$$\text{Moisture Content} = \frac{\text{Initial weight-Final weight}}{\text{Initial weight}} \times 100$$

c. Dry basis:
The dry matter content was calculated by
Dry basis(%) =100-moisture content

d. Determination of Ash Content: Apparatus:
a)Porcelain crucibles.
b)Muffle furnace, capable of maintaining a temperature of 625±25°C ensure enough oxygen is

admitted to the furnace chamber to complete removal of the carbonaceous material.

c)Desiccators.
Procedure:
About 5gms of sample was weighed accurately into a porcelain crucible. This is transferred into a muffle furnace set at 550°C and left for about 3hrs.About this time it had turned into white ash. The crucible and its content were cooled at room temperature in desiccators and weighed. The percentage of ash calculated.

$$\%\text{Ash Content} = \frac{\text{Weight of ash}}{\text{Original weight of sample} \times 100}$$

e. Estimation of Ascorbic Acid: Ascorbic acid:
Ascorbic acid content in the beetroot was estimated by using 2, 6 dichlorophenol indophenol dye as reported by Ranganna (1986) and Association of vitamin chemists (1966) as follows:

Reagents:
1. Metaphosphoric acid (3 %): In 100 ml distilled water 3 g metaphosphoric acid was dissolved.
2. Dye solution: Sodium salt of 2, 6 dichlorophenol indophenol dye (50 mg) was dissolved in about 150 ml of hot distilled water contained water containing 42 mg sodium carbonate. The mixture was cooled and diluted with distilled water to make up to volume of 200 ml. The dye solution was prepared fresh for every analysis.
3. Standard ascorbic acid solution (0.1 mg/ml) : L-ascorbic acid (100 mg) was dissolved in 3% metaphosphoric acid and the volume was made to 100 ml.
4. Standardization of dye: Standard ascorbic acid solution (5 ml) was mixed with 5ml of 3% metaphosphoric acid. It was titrated with dye solution until faint pink colour appeared and persisted for about 15 seconds. The dye factor was calculated as follows:
Dye factor = 0.5/Titrate value

Preparation of sample:
Take 10g of sample blend with 3 % metaphosporic acid (HPO3) make up to 100ml with HPO3 filter and centrifuge.

Extraction:
Take an aliquot (2-10)ml of metaphosporic acid and extract the sample and titrate with standard dye until end point pink color persists at least for 15sec.
Ascorbic acid (mg/100g) =(titre-blank) × dye factor × volume of extract × 100/ Extract taken for titration(ml)×Volume of sample take(ml)

f. Estimation of β carotene (mg/100g): Apparatus:
Acetone, Sand, Separating Funnel and Spectrophotometer
Reagents:
Motor and pestle, Hexane, Water and Anhydrous sodium sulphate

Procedure:
Weigh 4-5 gm of sample and grind it in motor and pestle by using acetone use pure sand during grinding. Extract 2-5 times until residue becomes colorless and filter the contents. Transfer to separating funnel and add 15ml hexane and 15ml water to separate water layer. Repeat the water washing for 2-3 times and collect the hexane layer. Make it up to 100ml with hexane and Add anhydrous sodium sulphate(remove any traces of moisture). Take readings on Spectrophotometer at 452nm.

$$\beta\ \text{Carotene} = \frac{\text{O.D} \times \text{Dilution} \times 100}{2.588 \times \text{weight of sample} \times 100}$$

g. Atomic absorption spectroscopy
The samples were analyzed using atomic absorption spectroscopy (AAS) model for determination of minerals at different wavelengths. The method used was by direct aspiration of sample digest, using air acetylene flame.

h. Estimation of Sodium (Na), Potassium (K) and Calcium (Ca): Apparatus:
Beaker, Hot plate, Conical flask and Measuring cylinder

Reagents:
1) 3% Nitric acid- Add 30 ml of Nitric acid to 1000ml water
2) 6% HCl- Add 60ml of HCl to 1000ml water

Procedure:
Weigh 1g of sample and add 50ml of 3% Nitric Acid and 6% HCl in equal amount of quantity and heat it on

hot plate till the solution becomes half in content. Filter through filter paper. Then make up the filtrate to 50ml with equal proportions of 3% Nitric Acid and 6% HCl. Then take the readings at Atomic Absorption Spectroscopy (AAS).

i. Estimation of crude fibre: Apparatus: Beaker, Desiccator and Crucible

Reagents:

1) 0.255 N H_2SO_4 : 7 ml of conc. H_2SO_4 is dissolved in distilled water to get one litre of solution.

2) 2) 0.313 N NaOH : 12.78 g of NaOH is dissolved in distilled water to get one litre of solution.

Procedure:

2-5gms of sample is weighed in to 500ml beaker and Add 200ml of 0.255N H_2SO_4(1.25%w/v). Boil for 30min keeping volume constant. Filter mix through a muslin cloth residue wash with hot water till free from acid (check using pH paper). Add 200ml of boiling 0.313N NaOH (1.25%w/v). Boil for 30min filter mixture through muslin cloth. Wash with hot water till free from alkali (check using pH paper). Wash with alcohol and ether transfer to a crucible. Dried overnight at 80-100ºC and weighed (We). Heat crucible in muffle furnace at 600ºC for 2-3 hrs cool in dessicator weighed again (Wa).

Note:

The difference in weights (We- Wa) represents the weight of crucible fibre.

$$\text{Crude fibre(g/100g)} = \frac{[100-(\text{moisture+fat})][\text{weight of fibre}]}{\text{Weight of sample} \times 100}$$

Where,

Weight of fibre = We- Wa

E. Preparation of soup: Procedure:

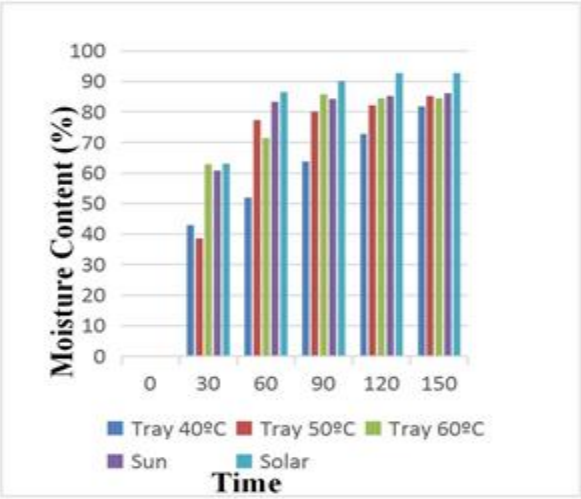
Fresh Beet root is taken and Dried at (Tray-40℃, 50℃and 60℃), Sun and Solar then Grind (mixer) to get beetroot powder. Add corn flour, spices and remaining ingredients to achieve soup consistency.

III. RESULTS AND DISCUSSION

Table 1: Physico-chemical properties of beetroot powder

Parameters	Before drying		Tray	After	Drying Sun	Solar
		40ºC	50ºC	60ºC		
Length of slice (mm)	1.76	0.95	0.82	0.78	0.64	0.58
Breadth of slice (mm)	2.05	1.15	1.13	1.12	1.10	1.09
Moisture content (%)	86.31	17.34	12.62	6.63	7.09	6.48
Time (hrs)	4	5	4	3	72	2
Dry basis (%)	13.69	82.66	87.38	93.37	92.91	93.52
Ash (%)	1.292	6.685	6.518	6.42	7.51	8.06
Ascorbic acid (mg/100 g)	8.9	7.8	7.612	7.46	7.32	7.28
β –Carotene (µg/g)	0.00018	0.000 12	0.000 11	0.000 09	0.000 07	0.000 06
Sodium (mg)	69.44±0. 83	68.73	68.64	68.83	69.11	69.23
Potassium (mg)	306±26.9	305.1 9	305.3 6	305.5 7	305.6 8	305.8 4
Calcium (mg)	17.28±2. 25	16.73	16.86	16.94	17.08	17.15
Crude fibre (g)	2.8±0.1	2.65	2.69	2.71	2.75	2.78

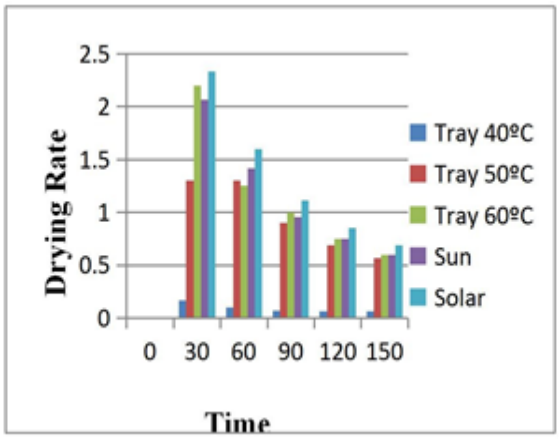
A. Moisture Content



graph no.1 Moisture content in different dryers for beetroot powder

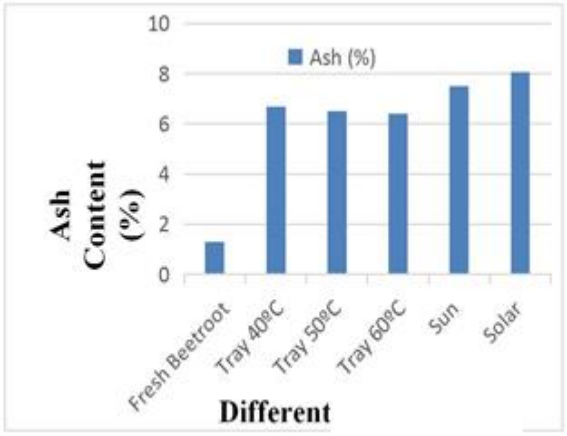
Moisture content was determined for finding the amount of moisture present after the drying of beetroot slices in 3 different dryers (Tray, Sun and Solar). The graph no.1 shows the moisture loss with time increases in 3 different dryers(Tray, Sun and Solar).

B. Drying rate



graph no.2 Effect of drying rate in different dryers for beetroot powder

C. Ash content (%)

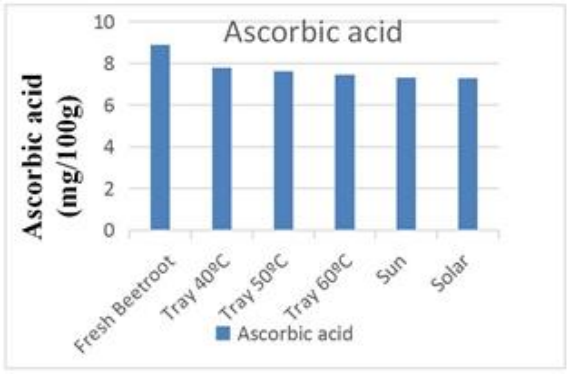


graph no.3 Ash content in different dryers for beetroot powder

Graph no .3 shows the graph of ash content vs different dryer. The ash content in fresh sample is 1.292%, Tray 40ºC is 6.685%, Tray 50ºC is 6.518%, Tray 60ºC is 6.42, Sun is 7.51% and Solar is 8.06%.

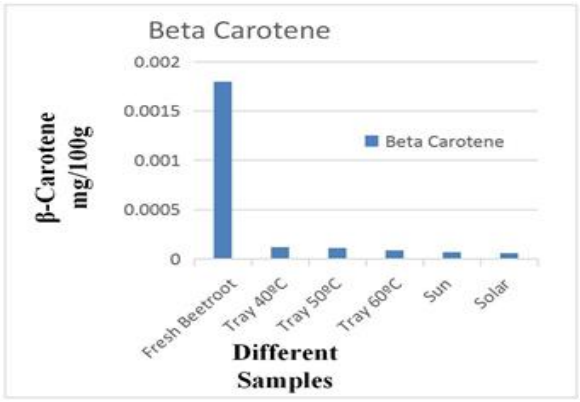
E. Ascorbic acid (mg/100g)

graph no.4 Ascorbic acid content in different dryers for beetroot powder



Graph no..4 shows it gradually decreases in solar dried sample compared to other drying methods. The ascorbic acid content in solar dried sample is 7.28 mg/100g.

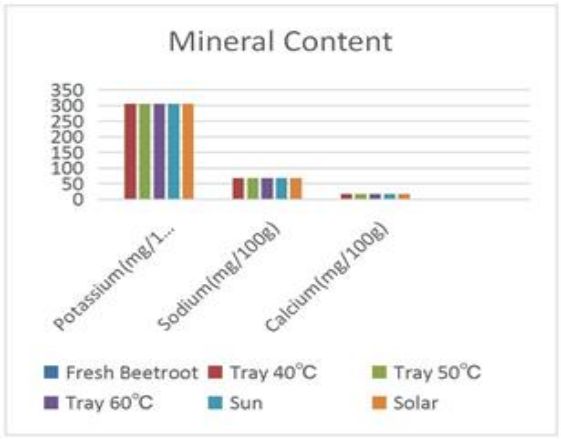
E. β-Carotene



graph no.5 β-Carotene content in different dryers for beetroot powder

As shown in the above graph no .5 there is a slight decrease in the β-Carotene content in beetroot samples at different dryers.

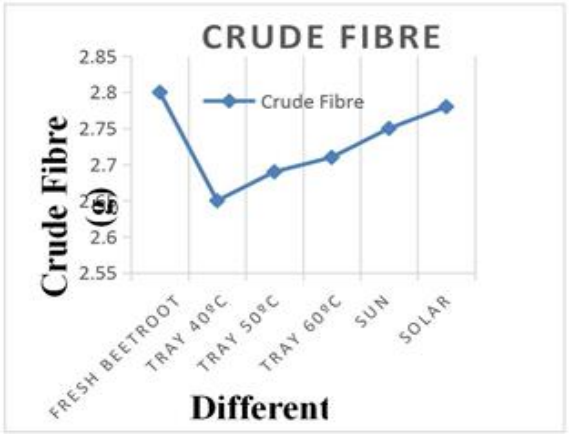
F. Mineral content



graph no.6 Mineral content in different dryers for beetroot powder

From the above graph no.6 we can say that there is higher content of minerals in Solar dried sample when compared to others.

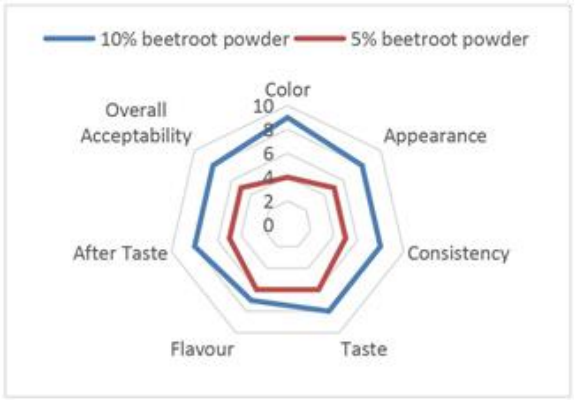
F. Crude fiber



graph no.7 Crude fiber in different dryers for beetroot powder

From the above graph no.7 we can say that there is higher content of crude fiber in Solar Dried sample when compared to other drying methods.

G. Sensory Web for Beet root powder soup (Solar dried Sample)



graph no.8 Comparison of sensory evaluation at two different proportions

Composition for soup

Table 2: Composition for soup

Ingredients	10% Beet root powder	5% Beet root powder
Beetroot powder	10g	5g
Corn flour	5g	10g
Spices	5g	5g
Salt	According to taste	According to taste
Sugar	3g	3g
Citric acid	1g	1g

IV. CONCLUION

In this chapter, the results obtained by physical properties, chemical analysis, nutritional analysis and organoleptic evaluation were discussed. After the dehydration of beetroot slices in 3 different types of dryers (Tray 40ºC, Tray 50ºC Tray 60ºC, Sun and Solar).Moisture content was lower in tray dried sample at 60ºC but colour and texture was not acceptable when compared to the solar dried sample. Dry matter content was higher in solar dried sample i.e., 93.52% when compared to other samples. Ash content (8.06%) was higher in solar dried sample. Crude fibre content (2.78g) was higher in solar dried sample. Comparison between Tray 40℃,50℃,60℃, and sun dryers results show that solar dryer is best. Solar dried sample is best for product development.10% beetroot powder formulation (solar dried) is acceptable by the sensory evaluation.

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