STUDY ON DEVELOPMENT OF BEETROOT POMACE FORTIFIED NUTRIBAR

Dissertation Report 1

Submitted by

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CERTIFICATE

This is to certify that Kirti Nehra has personally completed M.Sc. Dissertation-1entitled '**STUDY ON DEVELOPMENT OF BEETROOT POMACE FORTIFIED NUTRIBAR'** under my guidance and supervision. To the best of my knowledge, the present work is the result of her original investigation and study. No part of Dissertation-1 has ever been submitted for any other purpose at any university.

The project report is appropriate for the submission and partial fulfilment of the conditions for the evaluation leading to the award of Master of Food Science and Technology.

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DECLARATION

I hereby declare that the work presented in the Dissertation-1 entitled **'STUDY ON DEVELOPMENT OF BEETROOT POMACE FORTIFIED NUTRIBAR'** is my own original work. The work has been carried out by me at School of Agriculture, Lovely Professional University, Phagwara, Punjab, India under the guidance of **Er. Jasleen Kaur Bhasin**, Assistant Professor (Food Technology) of School of Agriculture, Lovely Professional University, Phagwara, Punjab, India for the award of the degree of Master of Science in Food Technology.

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I certify that the above statement made by the student is correct to the best of my knowledge and belief.

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CHAPTER 1 INTRODUCTION

Nutrition bars can be defined as the supplementary bars consisting of the cereals and high energy providing foods giving instant energy. These bars have high proportion of all essential nutrients from proteins to carbohydrates. In today's busy world one can look up to munching on a single nutrition bar to satisfy the hunger.

Beetroot scientifically known as ***Beta vulgaris rubra*** **(Bvr)** belongs to the chenopodiaceae family. It is the taproot portion of the beet plant. Beetroot has high amounts of nutrients present in it. In Hindi it is known as **chakundar**, **Remolachas** in Spanish and **Hong cai tou** in Chinese. Beetroot is a rich source if minerals like Magnesium, sodium potassium iron copper manganese. It also consist a lot of antioxidants and vitamins like A B and C. It is a very good source of dietary fibre and natural dye. It also constitutes phenolic compounds which have antioxidant properties. Beetroot has many healthful benefits therefore in the recent years it has been considered as one of the most essential functional food. This colourful vegetable is not just used a food but also used a medicinal plant and a food colorant. *(R.Tadimalla, 2017).*

Some of the different varieties of beetroot are as follows:-

- **Chioggia** is an Italian variety having distinct red and white striped flesh.
- **Farmanova** is cylindrical in shape and grows up to 8 inches.
- **Golden** is slightly carrot coloured but has the exact taste of a beetroot.
- **Detroit dark red** is the popular variety that grows 2 to 3 inches in diameter and can be grown over a wide variety of soils and temperature conditions.
- **Lutz green leaf** is a rare variety which grows up to 4 times the size of a normal beetroot.

1.2 Ingredients used for the development of the nutrition bar :

- Beetroot pomace
- Oats and porridge
- Dates
- Arabic gum
- Quinoa
- Chia seeds

1.3 Healthful benefits of the ingredients:

BEETROOT

- Inorganic nitrate present in the beet root helps in lowering the blood pressure and helps in reducing the risk of cardiovascular disease. As stated above nitrates in beetroot helps in lowering the rate of heart diseases and strokes. Beetroot helps in prevention of myocardial infection (obstruction of blood supply to a tissue in the heart).
- Also beetroot helps in improving the delivery of oxygen to the working skeletal muscles. In case the skeletal muscles are not getting enough oxygen they are impaired and decreases the capacity to move arms or legs which leads to decrease in physical activity and eventually increasing the risk of heart disease.
- Betalain present in beetroot has the potential to prevent cancer of breast, lungs and prostate and it significantly decreases the proliferation of cancer cells. If taken along with carrot it has the ability to treat leukaemia.
- Presence of calcium, betalain vitamin B iron and antioxidants in beetroot makes it one of the best foods for liver. Beetroot helps to thin the bile present in liver and allow it to flow easily through liver and small intestine.
- Betalain helps in eliminating the toxins from liver and make sure that they don't re enter the body. Zinc and copper present in beetroot helps in protecting the liver from oxidative stress.
- Beetroot are extremely beneficial when it comes to brain health. They help in improving brain neuroplasticity by improving the oxygenation of the cortex (area of brain which is more likely to get affected in the early stages of dementia). Nitrates

present in beetroot are converted to nitric oxide which allows the brain cells to communicate with each other hence enhances the brain health.

- Nitrates also improve the cerebral blood flow therefore enhances the functioning of brain. It also prevents Alzheimer, hyperglycemia and improves cognitive functioning. Beetroot helps in prevention of cataract. They are good source of carotenoids which reduces the risk of cataract.

OATS AND PORRIDGE

- Oats and Porridge are rich in carbohydrates, proteins and fibre than most other grains. They also have a good amount of vitamins and minerals. Oats consists of many powerful anti oxidants like avenanthramides which help in reducing blood pressure. These cereals are also rich in soluble fibre beta- glucan having numerous benefits. It helps in reducing levels of cholesterol and blood sugar.
- Oats also promotes healthy gut bacteria and increases the feeling of fullness. Oats may also help in lowering down the risk of heart disease by protecting the LDL cholesterol from getting oxidised. The presence of beta- glucan in the oats makes it one the most beneficial cereal products. It can improve the insulin sensitivity and level of blood sugar.
- Meals containing oats helps in losing weight which is achieved by slowing down the emptying of stomach and increasing the production of hormone related to satiety that is P44 (peptide 44). It is produced in the gut in response to eating. Finely grounded colloidal oats helps in treating dry and itchy skin. It helps to relieve symptoms of eczema and asthma in children. Also oat bran helps in treating constipation in elders.

QUINOA

- **Quinoa** is grown for its edible seeds that contain enough amounts of calories, carbohydrates and fat required for the body. Quinoa also contains omega 3 fatty acid. It consists of large amount of caretonoids like quercetin and kaempferol.
- Quinoa has more fibre than most other grains. It is free from gluten and has most of the essential amino acids that are required by our body. Quinoa helps improvement of metabolic health by lowering the blood sugar levels.

- Quinoa has good antioxidant properties which are further increased after sprouting of the seeds. Quinoa is not only tasty but it goes well with many food products therefore it is very easy to incorporate them into your diet.

CHIA SEEDS

- **Chia Seeds** also known as super food are loaded with many nutrients. CHIA stands for 'strength' and is used for their ability to provide sustainable energy. Chia seeds are rich in omega-3 fatty acid, calcium, magnesium, phosphorous.
- Chia seeds are loaded with anti oxidants which help in fighting against the production of free radicals responsible for aging and cancer. Fibre present in the chia has the ability to absorb 10-12 times their water in water. These seeds are high in quality protein and are really helpful in losing weight.

ARABIC GUM

- Arabic gum is dried edible gummy exudates derived from the Acacia species plant such as *Acacia senegal*, *Acacia laeta* and *Acacia seyal*. It is highly rich in soluble fibre and its colour may vary from pale to orange brown. Arabic gum has many healthful benefits to human health. It promotes good digestion. The soluble fibre present helps to ease the bowel movements and increase intestinal absorption. It may also help to alleviate constipation.
- Arabic gum consists of fibre that is considered as probiotic and it is really helpful in suppressing the growth of pathogenic bacteria. Many studies have shown that it is very effective in lowering down the cholesterol levels. The soluble fibre binds to the cholesterol and inhibits its absorption by the intestine. The cholesterol is later brought out of the body by excretion. Arabic gum plays an important role to keep teeth in a healthy state.
- It contains some amount of anti bacteria which prevent the growth of bacteria which is responsible for tooth decay. Anti oxidants present in Arabic gum help to fight free radicals. Free radicals are the main cause of oxidative stress which may lead to damage of cells and cancer in severe cases. It also helps in protecting liver. The fibre present in it has hepatoprotection effect that prevents the formation of fat cells in liver.

- It is also used in treatment of chronic liver disease as it helps in improving the function of kupfer cells and detoxification of body. *(MD.Anggi,2017). (Al. Mosawi, 2004)* stated that the supplementation of dietary fibre rich Arabic gum may help to reduce the need of dialysis in children who suffer end stage renal disease (ESRD). Acacia gum has the ability to reduce irritation and inflammation. It is especially effective in easing stomach and throat discomfort. *(T. Jewell, 2017).*

DATES

- Dates scientifically known as *Phoenix dactylifera* are the single pitted fruits belonging to the family of Arecaceae. It originated from the banks of Nile and Euphrates rivers of Egypt and Mesopotamia. Dates are grown extensively across all the continents during warmer climates. It is a drupe having outer fleshy part surrounding a hardened endocarp having a seed inside. It is generally oval in shape and 3 to 7 cms long. Depending upon the type of cultivation dates range from golden yellow, amber, bright red to deep brown in colour.
- Dates consist of phytonutrients, vitamins, and minerals that are essential for normal growth, development, and overall well-being. They are soft, easy to digest and consist of simple fructose and dextrose. Consumption of dates leads to the instant replenishment and revitalization of the energy. That's why they are the major part of the break during the Ramadan month.
- Dates are highly rich in dietary fibre which works as the bulk laxative and have the ability to prevent LDL cholesterol absorption in the gut. It also helps in reducing the colon cancer risk. Dates are also rich in tannins which are the polyphenolic antioxidants having anti-infective, anti-inflammatory, and anti-hemorrhagic (prevent easy bleeding tendencies) properties.
- They also have vitamin A in some minor amounts which is known to have antioxidant properties and very good for vision, maintaining healthy skin. They are excellent source of iron and potassium which are important for the formation of red blood cells and regulation of body fluids and blood pressure respectively.
- Date fruits are also rich in minerals like **calcium, manganese, copper**, and magnesium. The human body uses manganese as a co-factor for the antioxidant enzyme, *superoxide dismutase*.

CHAPTER 2 PROBLEM BACKGROUND

As the cases of adulteration in food products are increasing day by day it has become near to impossible to have a good nutritious product on the daily basis. Waste products of fruits and vegetables are neglected but they have the remarkable nutritional value. Fortification of the pomace along with the addition of other highly beneficial ingredients in the development of nutrition bar will only increase its nutritional value. The main challenge is to provide a complete meal like product for the children and youngsters who are having a busy schedule these days.

CHAPTER 3 REVIEW OF LITERATURE

3.1 Comparative analysis of fruit-based functional snack bars

S. Wadhwa. et al., (2009) analysed the fruit based functional snack bars having high dietary fibre and polyphenol contents. They prepared a control bar consisting of no fibre and the sample fruit bar fortified with apple fibre. The filling for the snack was formulated with and without APE i.e. apple polyphenol extract. The nutritional assessment of the snack was determined by performing the several tests for total dietary fibre (DF), uronic acid content, polyphenol content, protein content, and moisture content , water activity (aw), colour and hardness test. From the obtained results it was concluded that the snack bars fortified with apple fibre has the more amount of dietary fibre 5.3 % after baking and good quantities of phenolic content (2.87 and 2.22 mg catechin equivalent CtE/g . The control bars only had 1.45 mg CtE/g. From the phenolic profiles it was suggested that the snack bars would possess a better shelf life because no extra browning was caused by the addition of APE. Therefore, it was concluded that the bars fortified with the apple polyphenoal extract are good source of dietary fibre and can be considered as convenient food option.

3.2 Characterisation of food bars manufactured with agro industrial by products and waste

Paiva. et al., (2012) studied on the characterisation of food bars manufactured with agro industrial by products such as broken rice (BR), pequi nut (PN), soyabean exract residue (SER) and pineapple waste (PW). Distinct proportions of BR: SER respectively were used, amounting to five treatments: 1:0 (A); 3:1 (B); 1:1 (C); 1:3 (D) and 0:1(E) and fixed amounts of the other components. With the increase in the amount SER there was an increase in the moisture, protein, ash, mineral and dietary fibre contents were also increased directly and the amount of BR was decreased. But the calories were increased with the increased amount of SER. Increase in the values of soluble solids, pH and water activity was observed with the increase in the amount of SER. All the treatments presented slightly acidic pH and water activity bellow 0.6, favouring microbiological safety. According to Food and Agriculture Organization - FAO/WHO reference (1990) lysine was presented as the limiting amino acid with reference to the treatment A. All the treatments presented slightly acidic pH and water activity bellow 0.6, favouring microbiological safety. Form the study it was concluded that the treatment D and E were better than all other set of variables and the food bars enriched with dietary fibre has the higher nutritional values.

3.3 Study on Nutritional and functional potential of *Beta vulgaris rubra*

P. Ninfali and D. Angelino (2013) studied the nutritional and functional potential of beetroot (beta vulgaris rubra BVr). Their studies stated that BVr has apigenin flavonoids called vitexin, vitexin-2-O-rhamnoside and vitexin-2-O-xyloside which have antiproliferative activity on cancer cells lines. It also consists of betalains (secondary metabolites). These betalains also have anticancer activity and are used as natural dyes in food industry. Thats why beetroot be considered as a functional food. Moreover, the promising results of the phytochemicals in health protection suggest the opportunity to take advantage of the large availability of this crop for purification of chemopreventive molecules to be used in functional foods and nutraceutical products.

3.4 The Potential Benefits of Red Beetroot Supplementation in Health and Disease

T. Clifford. et al., (2015) research studies showed the effect of beetroot supplementation on inflammation, oxidative stress, cognition and endothelial function. They stated that beetroot has the high biological activity and potential utility therefore its use as the health promoting and disease preventing functional food has been growing rapidly. Beetroot is a source of nitrate and its ingestion provides a natural means of increasing *in vivo* nitric oxide (NO) availability. The consumption of beetroot helps in preventing and managing the pathologies associated with diminished NO bioavailability, notably hypertension and endothelial function. Beetroot is also being considered as a promising therapeutic treatment in a range of clinical pathologies associated with oxidative stress and inflammation. Its constituents like betalain pigments, display potent antioxidant, anti-inflammatory and chemo-preventive activity *in vitro* and *in vivo*.

3.5 Study on Antioxidant and Antimicrobial Activities of Beet Root Pomace Extracts

D. Cvetković.et al., (2011) studied about the in vitro antioxidant and antimicrobial activities of ethanol, acetone, and water extracts of beet root pomace. Total contents of phenolics (316.30–564.50 mg GAE/g of dry extract), flavonoids (316.30–564.50 mg RE/g of dry extract), betacyanins (18.78–24.18 mg/g of dry extract), and betaxanthins (11.19–22.90 mg/g of dry extract) after solid-phase extraction were determined spectrophotometrically. The antioxidant activity was determined by measuring the reducing power and DPPH scavenging activity by spectrometric method, and hydroxyl and superoxide anion radical scavenging activity by ESR spectroscopy.

In general, the reducing power of all the beet root pomace extracts increased with increasing concentrations. The DPPH-free radical scavenging activity of the extracts, expressed as EC50, ranged from 0.133 mg/ml to0.275 mg/ml. Significant correlation was observed between all phytochemical components and scavenging activity. 0.5 mg/ml of ethanol extract completely eliminated hydroxyl radical, which had been generated in Fenton system, while the same concentration of this extract scavenged 75% of superoxide anion radicals. In antibacterial tests, *Staphylococcus aureus* and *Bacillus cereus* showed higher susceptibility than *Escherichia coli* and *Pseudomonas aeruginosa.*

3.6 The content of total polyphenols and antioxidant activity in red beetroot

P. Kavalcová. et al.,(2015) studied about the total polyphenol and antioxidant activity in red beetroot which is an important raw material of plant origin having proven positive effects on the human body. Samples of beetroot were collected at full maturity stages from different areas. These samples of were homogenized and prepared as an extract. 50 g of cut beetroot was extracted by 100 ml 80% ethanol for 16 hours. These extracts were used for analyses. The content of the total polyphenols was determined by using the Folin-Ciocalteu reagent (FCR) and absorbance was measured at 765 nm of wavelength against blank. Antioxidant activity was measured using a compound DPPH˙ (2.2-diphenyl-1-picrylhydrazyl) at 515.6 nm. It was detected, that total polyphenols content in samples ranges from 820.10 mg/kg to 1280.56 mg/kg. Statistically significant highest value of total polyphenols was recorded in beetroot in variety of *Renova* from locality of Sliač (1280.56 ±28.78 mg/kg). Statistically significant the lowest content of total polyphenols was recorded in beetroot in variety of *Renova* from the village Sihelné (820.10 ±37.57 mg/kg). The values of antioxidant activity were in interval from 19.63% to 29.82%.

3.7 Manufacturing cereal bars with high nutritional value through experimental design

R. Covino. et al., (2015) said that organizations are play an important role in improving public health by encouraging a nutritious and balanced diet to minimise the chances of chronic dieseas. Therefore cereal bars can be considered as a good option for having low calories and source of fibre. Main objective was to formulate a cereal bar having good amount of dietary fibre, iron, vitamin A and E to help achieve the daily requirements. Eight formulations plus the focal point were prepared through experimental planning. For each block and texture sensory analysis was conducted with 110 tasters. Proximate analysis for all

the formulations was done to present the best results. At last it was concluded that the new product developed fibre level higher than the mean values for commercial products.

3.8 Impact of processing of red beet on betalain content and antioxidant activity

K. Ravichandran. et al., (2011) said that high concentrations of betalains in red beet are used as food additives and colorants as they have got good health promoting properties. The stability of the betalains is influenced after the processing which affects the acceptability of the red beet. The study was done to identify the influence of various processing techniques such as microwaving, boiling, roasting and vacuuming on the red beet and was evaluated on the basis of betalains content and antioxidant activity. It was concluded that red beet treated under vacuum and microwave (900 W and 1800 W) for 30 seconds were having 20 %, 7% and 19% of betalains respectively but a decrease was observed due to boiling and roasting. Microwave treatments with 450W and 900W showed an increase in the betalain content estimated using the HPLC but decreased with 1800 W. 2 to 3 times increase in the antioxidant activity were observed in the boiling and roasting treatments.

3.9 A comparative study of the purification of betanin

Betanin is a natural pigment with antioxidant properties which is mainly used as a food colourant. *L. Goncalves. et al., (2011)* worked on the quantification of betanin from beetroot juice, beetroot powder and standard betanin using the spectrophotometric and chromatographic techniques . By using a mixed three function model all three samples were deconvoluted from the absorption spectra. It was observed that during the processing violet and red coloured impurities were formed in the beetroot powder. Seven different methods were used for the purification of betanin from the complex matrices out of which ion exchange chromatography was found to be the most efficient one. Good results were also obtained from the reversed phase HPLC and column chromatography. Using the quantum mechanical methods the retention time of isobetanin was compared to betanin under reversed phase conditions.

3.10 Compositional characteristics of commercial beetroot products and beetroot juice prepared from seven beetroot varieties grown in Upper Austria

Beetroot scientifically known as *Beta vulgaris* has active substances betalains and inorganic nitrate. *J. Wruss. et al.,* (*2015)* collected seven different varieties from upper Austria to determine minerals, betalains, oxalic acid, phenolic acids, and sugars in juice of the beetroot. Substances such as nitrates showed major variation whereas certain minerals and sugars

showed minor variation. Fresh beetroot juice contained total betalains in the range 0.8 to 1.3 g/L contributing to 70-100 % of total phenols. Also, another phenol hydroxycinnamic acid contributed to 2.6% of total phenols. With an average of total 7.7 % sugar composition was found to be same in all varieties. The concentration of oxalic acid was in the range 0.3 – 0.5 % g/L fresh juice and showed minimum variation. Large variations of the nitrate levels, ranging from 0.01 to 2.4 g/L, were found.

3.11 Studies on physicochemical properties of the plant gum exudates of Acacia Senegal, Acacia sieberiana and Acacia nilotica

A.K. Yusuf (2011) studied the different properties of three different varieties of plant gum exudates and confirmed that there are some differences in the physicochemical properties in the varieties of gums. The results were obtained as moisture (13.40-16.20%); water solubility at 30^0C (38-45%); pH of 25% solution (4.50-5.00); relative density of 20% solution (300C) (1.23-1.32); melting temperature (289-320^0C); relative viscosity of 1% solution (20.18-24.80); total ash (3.30-3.54%); nitrogen (0.38-0.42%); protein (2.51-2.77%) and total soluble fibre (77.99-80.41%). No tannin content was found in the samples during the analysis. (Ca), magnesium (Mg), iron (Fe), sodium (Na) and potassium (K) were found as the predominant minerals whereas Copper (Cu), nickel (Ni), cobalt (Co), manganese (Mn), chromium (Cr), zinc (Zn) and lead (Pb) were not detected.

CHAPTER 4 RESEARCH OBJECTIVES

1. Development of beetroot pomace fortified nutrition bar.
2. Estimation of quality characteristics of the developed nutrition bar.
3. Storage study of the formulated bar.

CHAPTER 5 MATERIALS AND METHODS

5.1 Procurement of raw material

All the raw materials were procured from the local market of Phagwara, Punjab and stored at room temperature. Good quality of beetroot was selected, cleaned and graded accordingly which was further used to extract out the pomace having good amount of dietary fibre.

5.2 Method of preparation

The nutri bar was manufactured using the solid ingredients where the solid phase was made up of ingredients in varying amounts of the beetroot pomace in the form of the waste. The mixture was combined with fixed amounts of oats and porridge and dates were added as a substitute for sugar. Also, chia and quinoa seeds were added to enhance the nutritional value of the bar.

5.3 Proximate Analysis

5.3.1 Moisture Content

Initial moisture content was determined by drying the sample to a constant weight in a hot air oven.

$$\% \text{ moisture} = \frac{W2 - W3}{W2 - W1} \times 100$$

Where, W1 is weight of the empty dish

W2 is weight of the dish with sample before drying

W3 is weight of the dish with sample after drying

5.3.2 Ash Content

The known amount of sample was charred using a burner or hot plate and transferred to a muffle furnace having the temperature of $525^{O}C$.

$$\% \text{ total ash} = \frac{W2 - W}{W1 - W} \times 100 \times (100 - M)$$

Where, W is weight of empty crucible

W1 is weight of crucible + sample

W2 is weight of crucible+ ash

M is % moisture of the sample

5.3.3 Total dietary fibre

Total DF content of the bars was determined using the Megazyme International total DF assay adopted from AACC method.

5.3.4 Bulk Density

The volume of 100 g of the product using a measuring cylinder was determined after tapping the measuring cylinder (250 ml) on a wooden plank until no visible decrease in volume was noticed. Based on the weight and volume, the apparent (bulk) density was calculated.

5.3.5 Free fatty acid (FFA)

According to AOAC 2000 to determine the free fatty acid content, the sample was refluxed with petroleum ether in a water bath to extract fat. To 5 g of fat, warm neutral alcohol and petroleum ether were added along with few drops of phenolphthalein indicator and titrated against 0.1 N NaOH.

$$\%FFA = \frac{\text{Titre Value X N X 56.1}}{\text{weight of sample}} \text{ X 100}$$

5.3.6 Viscosity

Slurry of the sample was prepared by dispersing the sample in distilled water and viscosity was measured using a Brookfield viscometer.

5.3.7 Total Protein Content

It was estimated by the Lowry method where BSA solutions in water at different concentrations (ranging from 0 to 1000 l g/ml) were used as standards to establish a calibration curve.

5.3.8 Total Fat Content

Pre weighed sample was take in thimble plugged with cotton. It was placed directly into the extraction tube of the appartus. It was determined using the soxhlet apparatus.

$$\% \text{ Fat} = \frac{\text{W4- W1}}{\text{W3- W}} \text{ X 100}$$

Where,

W1 is weight of empty flask

W2 is weight of empty thimble

W3 is weight of thimble + sample

W4 is weight flask + oil

5.3.9 Total phenolic content determination

Total phenolic content was analysed by the method of Singleton, Orthofer, and Lamuela-Raventos (1997) and expressed as catechin equivalents (CtE). The absorbance was detected at 760 nm. A calibration curve (absorbance vs. catechin concentration mg (CtE/ml) was established for the extraction medium.

5.3.10 Texture Analysis

Texture of bars was determined at different storage intervals with some modifications by using a texture analyzer.

5.3.11 Water activity

It was measured using the water activity analyzer. The analyser has to be standardized using sodium chloride or lithium chloride.

5.3.12 Colour determination

Colour is one of the most important physical attributes which determine the quality of a product. To determine the colour we will use the Hunter Colour Lab in accordance with L* a* b* space system.

$$\Delta E = [(a^*-a_o^*)^2 + (b^*- b_o^*)^2 + (L^*- L_o^*)^2]$$

5.3.13 Total betalain content

The total betalain (betacyanin and betaxanthin) pigment content in the extract was measured spectrophotometrically. The wavelengths of 535 nm and 476 nm were used for betacyanin and betaxanthin analysis, respectively.

5.3.14 Total Flavonoid Content

Total flavonoids were determined using the colorimetric assay. The absorbance was measured at 510 nm against the control that had been prepared in the same manner only with

replacing the extract with distilled water. Total flavonoid content was expressed as mg rutin equivalents (RE) per g of extract.

CHAPTER 6 RESULTS AND DISCUSSIONS

The moisture, ash and fat content of oats were found to be 9.8 % 2.02 % and 6.5%. Similar results were observed by *Y.Liu et al., (2000), Zhang et al., (2014)* and *Maboodurrahman (2015).*

The moisture, ash and fat content of porridge were found to be 8.2 %, 5.04% and 0.1 % respectively. Similar results were observed by *Rana et al., (2015)* as 9.79 % 2.5% and 0.1 %.

The moisture, ash, and fat content of arabic gum were obtained as 19.52 % 3.3 % and 9.12%. Similar results were obtained by *Yusuf (2011)* as 16.20 % and 3.24 % for moisture and ash content.

The moisture content of beetroot pomace powder was found to be 66.6 %. Total phenolic content and total flavonoids were obtained as 0.1248 (mg/g GAE) and 255 mg/g .Similar results were also observed by *Wruss et al., (2015)* as 0.146 (mg/g GAE) and 253 (mg/g).

SAMPLE	MOISTURE CONTENT (%)	ASH CONTENT (%)	FAT CONTENT (%)
OATS	9.8 ± 1.8	2.02 ± 1.0.2	6. 5 ± 0.7
PORRIDGE	8. 2 ± 1	5. 04 ± 2.2	0.1 ± 0.05
GUM ARABIC	19. 52 ± 0.2	3.3 ± 0.2	9.12 ± 0.07

TABLE 6.1 Chemical compositions of the raw materials. (n=3)

SAMPLE	MOISTURE CONTENT (%)	TOTAL PHENOLIC CONTENT (mg/g GAE)	TOTAL FLAVONOIDS (mg/g)
BEETROOT POMACE	66.6 ± 0.5	0.1248 ± 0.002	255 ± 0.64

TABLE 6.2 Chemical composition of the beetroot pomace. (n = 3)

CHAPTER 7 EXPECTED OUTCOMES

The development of beetroot pomace fortified nutrition bar rich is in various nutrients and dietary fibre. It can be considered as a complete meal which can be eaten to gain instant energy and to satisfy hunger pangs. It can also have a good commercial value as it is highly beneficial especially for school going children and college students to meet their daily body requirements. Incorporation of waste as ingredients in the making of food bars can be proved as great utilization because of the nutritional and functional value.

CHAPTER 8 REFERENCES

1. Banach, J.C., Clark, S., and Lamsal,B.P., 2014. Texture and other changes during storage in model high-protein nutrition bars formulated with modified milk protein concentrates. LWT Food Science and Technology. 56, pp. 76-86.
2. Boustani, P., and Mitchell, V.W., 1990.Cereal Bars: A Perceptual, Chemical and Sensory Analysis, *British Food Journal*, 92(5), pp.17 – 22.
3. Clifford, T., Howatson, G.,West, and Stevenson, E., 2015.The Potential Benefits of Red Beetroot Supplementation in Health and Disease. NCBI National Center for Biotechnology Information, U.S. National Library of Medicine. 7(4) pp- 2801–2822.
4. Corrigan, V., Hedderley, D., and Harvey,W., 2012. Modeling the shelf life of fruit filled snack bars using survival analysis and sensory profiling techniques. *Journal of Sensory Studies*. (27) pp- 403- 416.
5. Covino, R., Roberto, A., Monteiro, G., Silva Scapim, M.R., Marques, D.R., Lívia Benossi and Monteiro, C.C.,2015 .Manufacturing cereal bars with high nutritional value through experimental design. Acta Scientiarum. Technology. 37(1). pp- 149-154.
6. Gonçalves, L., Trassi, M., Dörr, N., Teixeira dos Santos, M., Baader, W., Oliveira Jr, V., Bastos, E., 2011. A comparative study of the purification of betanin. Food Chemistry. 131 (2012), pp- 231–238.
7. Jasna M.C., Sladjana, S., Savatović, S., Ćetković, J., Vulić,. Dj ilas, M., and Dragoljub, D.C., 2011. *Czech J. Food Sci.* 29(6), pp. 575-585.
8. Jewell, T., 2017. 7 uses for acacia. Healthyline. Newsletter.
9. Kavalcová, P., Bystrická, J., Tomáš, J., Karovičová, J., Kovarovič, J., Lenková, M., 2015 The content of total polyphenols and antioxidant activity in red beetroot. *Potravinarstvo Slovak Journal of Food Sciences, 9(1).*
10. Liu, Y., Hseih, F., Heymann, H., and Huff, H. 2000. Effect of process condition on the physical and sensory properties of extruded oat-corn puff. JFS: Sensory and Nutritive qualities of food. 65(7), pp 1253.
11. Maboodurrahman., and Birara, S., 2015. Sensory and analytical study of oats chocolate chips cookies. International journal of science and research. 4(10) , pp-793.

12. Mcmahon, D.J., Adams, S.L. and Mcmanus,W.R., 2009. Hardening of High-Protein Nutrition BarsandSugar/Polyol–Protein Phase Separation. *Journal of food science*. 74(6),pp 1750-3841.
13. Muhammad, N., Rehman, S., FaqirMuhammad, Anjum., Murtazaand, M.A., Mueen-ud-Din., 2012.Development, Characterization and Optimization of Protein Leveling Date Bars Using Response Surface Methodology. *The scientific world journal.* 20 (12) pp-10.
14. Ninfali, P., and Angelino, D., 2013. Nutritional and functional potential of Beta vulgaris cicla and rubra. NCBI National Center for Biotechnology Information, U.S. National Library of Medicine. pp- 188-199.
15. Paiva1, A.P., Barcelos,M.F., Ribeiro Pereira, J.A., Ferreira, E., Ciabotti, S., 2012. Characterisation of food bars manufactured with agroindustrial byproducts and waste. *Journal of the Association of Official Analytical Chemistry*. 36(3), pp 333-340.
16. Pradeep, P.M., Dharmaraj, U., Sathyendra Rao, B., Senthil, A., Malleshi, N.G., and Singh, V., 2013. *Journal of food science technology,* Springer, Mysore.
17. Rana, G., Khan, M.A., and Singh, Y., 2015. Quality Assessment of Multigrain Dalia Formulated From Cereals and Legume Mix. *Indian Res. J. Genet. & Biotech. 7(4), pp- 415 – 421.*
18. Ravichandran, K., Thaw Saw, NM., Mohdaly, A., Ahmed M.M., Kastell, A., Riedel, H., Cai, Z., Dietrich Knorr, D., Iryna Smetanska, I., 2011. Impact of processing on red beet on betalain content and antioxidant activity. Food research International. 50(2013), pp- 670-675.
19. Sun-Waterhouse, D. ,Teoh, A., Massarotto, C., Wibisono, R., Wadhwa, S.,2010. Comparative analysis of fruit-based functional snack bars. *Journal of food chemistry*. 119, pp. 1369–1379.
20. Tadimalla, R.T., 2017. Top 20 healthful benefits of beetroot. Ingredients and uses © stylecraze.
21. Vijayanand, P., Yadav, A. R., Balasubramanyam, N., and Narasimham, P., 2000. Storage Stability of Guava Fruit Bar Prepared Using a New Process. 33(2), pp-133-137.
22. Wruss, J., Waldenberger, G., Huemer,S., Uygun, P., Lanzerstorfer,P., Muller, U., Hoglinger,O., and Weghuber, J., 2015. Compositional characteristics of commercial beetroot products and beetroot juice prepared from seven beetroot varieties grown in Upper Austria. Journal of Food Composition and Analysis. 42 (2015), pp-46–55.

23. Yusuf, A.K., 2011. Study on some physicochemical properties of the plant gum exudates of *Acacia senegal* (DAKWARA), *Acacia sieberiana* (FARAR KAYA) and *Acacia nilotica (*BAGARUWA). Journal of Research in National Development. 9(12), pp- 1596 – 8308.
24. Zhang, C., Zhang, H., Wang, L., and Qian, H., 2014. Physical, functional and sensory characteristics of cereal extrudates. International journal of food properties. 17(9), pp-1923.