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Development and quality evaluation of pasta incorporated with beetroot powder

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Abstract

The study was conducted with the aim of increasing protein content of the pasta and utilizing more nutritious beetroot powder. The pasta was formulated using refined flour and millet flour 50% each for control sample. Beetroot powder was incorporated by varying the proportion of millet flour from 50-10% and beetroot powder from 0-40% keeping refined flour as constant 50%. The pasta was made by using hand operated twin screw extruder. The cold extruded pasta was dehydrated at different drying temperature (55, 70 and 85 °C). The pasta was evaluated for its nutritional and sensory properties. The beetroot powder increased in the formulations of pasta was 0-40% that increased mineral content (0.71-1.59) %, crude fibre (0.90-2.02) % and protein content (11.21-12.85) % moisture (9.30-8.52) %, fat content (0.90-1.10) % and carbohydrate content (73.89-76.98) %. The flour and beetroot powder could be used to produce the quality pasta with acceptable sensory properties as color (7-8.5), flavour (6.9-8), texture (7-8.4), taste (6.9-8.5) and the overall acceptability (7.0 – 8.3). On sensorial evaluation highly accepted formulation was (T₃S₂) refined flour 50%, millet flour 30% and beetroot powder 20%.

Keywords: Beetroot, pasta, millet flour, wheat flour, formulation, physiochemical properties

Introduction

Extrusion is a process which combines several unit operations including mixing, cooking, kneading, shearing, shaping, and forming. Their main role was developed for conveying and shaping fluid forms of processed raw materials, such as doughs and paste. (Abecassis J., *et al.*, 1994) [2]. An extruder is a thermodynamic unit which involves the combination of heat, pressure, and mechanical shear (Saini *et al.*, 2018) [30]. Pasta is a staple food in many cultures made from unleavened dough which is stretched, extruded, or rolled flat and cut into one of a variety of shapes known to have a low glycaemic index (Aalami, *et al.*, 2007) [1]. While long strips may be the most common, many varieties forms of pasta include long shapes, short shapes, tubes, flat shapes and sheets, miniature soup shapes, filled or stuffed and specialty or decorative shapes. Extruded food materials undergo various transformations, including starch gelatinization, fragmentation, and protein denaturation, which affect the properties of the extrudates. (Dwivedi *et al.*, 2017) [5] Instant pasta is currently consumed and enjoyed worldwide due to convenience, ease of cooking, widely acceptable taste, flavour as well as affordable prices. (Mounika *et al.*, 2019) [19].

Beetroot powder

Beetroot powder is a superfood made of the low-temperature beetroot grinding process. It is slightly sweet, and it has an earthy smell. Beetroot powder is a natural remedy used for health and self-care as well as for cooking. Interestingly, beetroot powder has the same nutrition value as the whole product – in the very production process, beets are removed from the juice and then grounded. Such a procedure allows the manufacturer to save all the useful properties of the beetroot. (Lucky, *et al.*, 2020) [15]

Health benefits

Betalains have antiviral effects (Strack *et al.*, 2003) [33] and can inhibit the cell proliferation of human tumour cells (Reddy *et al.*, 2005). Consumption of red beet which are rich source of antioxidants can contribute to protection from age related diseases. According to (Vinson *et al.*, 1998), (Zitnanova *et al.*, 2006) red beet is one of the most potent vegetables with respect to antioxidant activity. Significant amount of vitamin C, Vitamin B1, B2, niacin, B6, B12 are found in beetroot, while the leaves are an excellent source of vitamin A consuming beetroot helps in curing many diseases such as anaemia, blood pressure, cancer, dandruff, gastric

ulcers, kidney ailments, liver toxicity or bile ailments like jaundice, hepatitis, food poisoning, diarrhoea or vomiting. In addition to their usefulness as colorants, Betalains play an important role in human health because of their pharmacological activities such as antioxidant, anti-cancer, anti-lipidemic and antimicrobial. In addition to the health beneficial compounds, however, beetroots also contain significant quantities of oxalic acid. Oxalic acid is a strong metal ion chelator interfering with iron and calcium metabolism and can lead to the formation of nephritis (Holmes *et al.*, 2004)

Procurement of Raw Material

Beetroot

Fresh beetroot was purchased from local fruit sellers in Allahabad, India.

Millet flour

In regular grocery store in the group of millet flour you can find millet flour among other available foods. This food belongs to the cereal grains and pasta group. Since millet flour is a food high in carbohydrates, we can say that this millet flour is a source of immediate energy required by the body to perform numerous mental and physical activities. Addition of bajara millet flour to semolina in making the pasta not only improves the nutritional properties but also found an attractive colour and thus affected the appearance. The extent of tinge may thus be considered as an indicator of bajara millet addition and reflects the nutritional enhancement.

Semolina

Semolina pasta has higher plasticity as compared to flour pasta while flour pasta has more elasticity probably due to rich gluten content. Due to the higher plasticity of semolina pasta, the batter has a sufficient consistency which makes sure that the pasta does not lose its extruded shape when it is cooked. This flour is good thicker, grainer kinds of pasta due to its coarser texture.

Treatments

The treatment comprised of 5 treatments, 1 factor, 5 different temperatures. The evaluation of physic-chemical changes and sensory qualities were done. The details of the pre-treatments, drying methods and their combinations were carried out as given below.

Table 1: Formulation of treatment

Sr.no.	Treatment	Refined flour (g)	Millet flour (Bajara) (g)	Beetroot powder (g)
1	S ₀	50	50	0
2	S ₁	50	40	10
3	S ₂	50	30	20
4	S ₃	50	20	30
5	S ₄	50	10	40

Tray Drying

Treatment temperature combination to processing of beetroot powder

1. Tray drying + beetroot slices + 65 °C 9 Hrs
2. Tray drying + beetroot slices + 90 °C 7 Hrs

Treatment temperature combination to beetroot after processing

- T₁-55 °C
- T₂-70 °C
- T₃-85 °C
- T₁S₀ Tray drying + control + 55 °C
- T₁S₁ Tray drying + 55 °C
- T₁S₂ Tray drying + 55 °C
- T₁S₃ Tray drying + 55 °C
- T₁S₄ Tray drying + 55 °C
- T₂S₀ Tray drying + control + 70 °C
- T₂S₁ Tray drying + 70 °C
- T₂S₂ Tray drying + 70 °C
- T₂S₃ Tray drying + 70 °C
- T₂S₄ Tray drying + 70 °C
- T₃S₀ Tray drying + control + 85 °C
- T₃S₁ Tray drying + 85 °C
- T₃S₂ Tray drying + 85 °C
- T₃S₃ Tray drying + 85 °C
- T₃S₄ Tray drying + 85 °C

Materials Required

Ingredients (wheat flour, refined flour, semolina, beetroot) which are collected from the local market of Prayagraj. It should be in good quality and the beetroot are fresh, dust free and good quality.

Firstly, the beetroot is washed and make it dust free and green leaves free. Then the outer layer is removed, and it cut into the small size. Then are collected in the tray for tray drying process and are put for drying process for nearly 5 hrs for 70 degrees Celsius.

After drying are collected and with the help of grinder make it in small size.

B. Flow chart of beetroot pasta processing

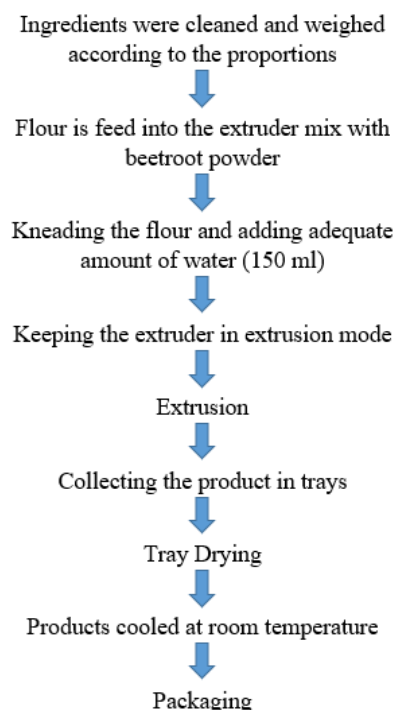


Fig 1: Schematic diagrams for preparation of beetroot pasta.

Result and Discussion

This chapter explains the results of all experiments and tests performed on the research work entitled “Development And Quality Evaluation Of Incorporated Beetroot Pasta.” Different types of flours like wheat flour, refined flour and the other ingredients as semolina, beetroot powder, salt, and water were added in different quantity in treatments T₀, T₁, T₂ and T₃ as shown in Table. The formulation such as S₀, S₁, S₂, S₃, S₄ as changes in the millet flour, refined flour, and beetroot powder shown in the table as formulation of treatments. The work was organized in two subsequent steps; the first was aimed to development of pasta incorporation with beetroot powder whereas, in the second step to evaluate physiochemical and sensory analysis of incorporated beetroot pasta. Physiochemical attributes like moisture content, protein, fat, ash content, fibre, and sensory evaluation of beetroot pasta were evaluated. The experiment was carried out during Jan to June 2021 in Department of Food Process Engineering of SHUATS, Prayagraj, Uttar Pradesh.



Fig 2: Developed beet root pasta

Chemical evaluation of incorporated beetroot pasta

Table 2: Moisture content of incorporated beetroot pasta.

Treatment	Moisture (g)
T ₁ S ₀	9.30
T ₁ S ₁	9.13
T ₁ S ₂	8.70
T ₁ S ₃	8.53
T ₁ S ₄	8.50
T ₂ S ₀	9.32
T ₂ S ₁	9.09
T ₂ S ₂	8.61
T ₂ S ₃	8.54
T ₂ S ₄	8.53
T ₃ S ₀	9.33
T ₃ S ₁	9.10
T ₃ S ₂	8.52
T ₃ S ₃	8.57
T ₃ S ₄	8.55

Difference in moisture content of different treatment of incorporated beetroot pasta.

Moisture content is important factor that determines the product shelf life. The different treatment of pasta with different treatment according to different formulation are given in table no. The moisture content of the product is in the range of 8.50 - 9.33g/ 100g. The previous studies ranging from 7.96 – 9.30g/ 100g. (Mounika *et al.*, 2018)

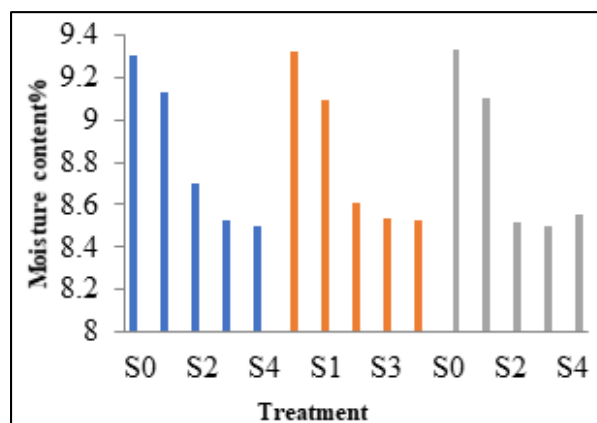


Fig 3: Effect of moisture on different treatment of beetroot pasta.

Table 3: Protein content of incorporated beetroot pasta.

Treatment	Protein (g)
T ₁ S ₀	11.21
T ₁ S ₁	11.69
T ₁ S ₂	12.17
T ₁ S ₃	12.40
T ₁ S ₄	12.81
T ₂ S ₀	11.20
T ₂ S ₁	11.72
T ₂ S ₂	12.10
T ₂ S ₃	12.35
T ₂ S ₄	12.70
T ₃ S ₀	11.25
T ₃ S ₁	11.75
T ₃ S ₂	12.15
T ₃ S ₃	12.30
T ₃ S ₄	12.85

Difference in protein content of different treatment of incorporated beetroot pasta

Protein plays an important part in the body building. It consists of amino acid which are beneficial for the daily body functioning. In this study of extruded sample, the protein content is in range of 11.20 – 12.85g/ 100g respectively. In these extruded products, it is observed that there is an increase in protein content gradually with the increase in proportion of beetroot powder. The similar results were observed as 11.52 – 12.08g/ 100g. (Zahrat *et al.*, 2016)

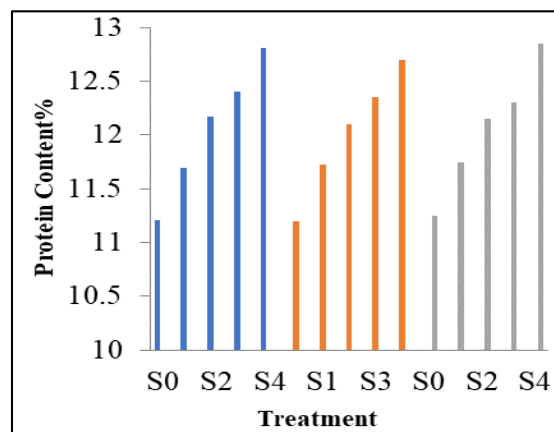


Fig 4: Effect of protein content on different treatment of beetroot pasta.

Table 4: Ash content of incorporated beetroot pasta.

Treatment	Ash (g)
T ₁ S ₀	0.71
T ₁ S ₁	0.89
T ₁ S ₂	1.10
T ₁ S ₃	1.29
T ₁ S ₄	1.58
T ₂ S ₀	0.69
T ₂ S ₁	0.87
T ₂ S ₂	1.05
T ₂ S ₃	1.30
T ₂ S ₄	1.53
T ₃ S ₀	0.72
T ₃ S ₁	0.88
T ₃ S ₂	1.09
T ₃ S ₃	1.25
T ₃ S ₄	1.59

Difference in ash content of different treatment of incorporated beetroot pasta

The table shows the effect on ash content of beetroot pasta as per the different formulations and different treatment of incorporated beetroot pasta. The ash value refers to the inorganic residue that remains after burning of the organic matter in a food sample these residues arise from the mineral matter in a sample and it exist in organically bound form or in the inorganic form. The ash obtained helps in determination of individual ash value of extruder samples in the range of 0.69 – 1.59g/ 100g. As per the previous studies the ash content is normally different as 0.75 – 1.18g/100g. studied by (Mounika *et al.*, 2018) and (Zahrat *et al.*, 2016) was studied that ash content is 0.71 – 1.06g.

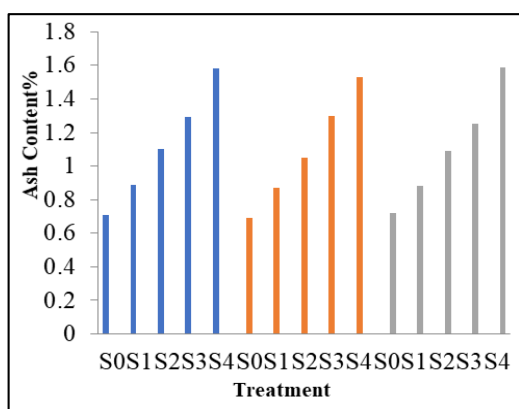


Fig 5: Effect of ash content on different treatment of beetroot pasta.

Table 5: Crude fibre content of incorporated beetroot pasta.

Treatment	Crude Fiber (g)
T ₁ S ₀	0.90
T ₁ S ₁	1.51
T ₁ S ₂	1.85
T ₁ S ₃	1.93
T ₁ S ₄	2.07
T ₂ S ₀	0.92
T ₂ S ₁	1.47
T ₂ S ₂	1.83
T ₂ S ₃	2.03
T ₂ S ₄	2.10
T ₃ S ₀	0.91
T ₃ S ₁	1.53
T ₃ S ₂	1.80
T ₃ S ₃	1.97
T ₃ S ₄	2.02

Difference in crude fibre content of different treatment of incorporated beetroot pasta

It gives bulk to the diet, consisting largely of cellulose followed by hemicellulose, pentosans, and nitrogen substances. Fibre helps to maintain the health of gastrointestinal track. The fig. shows that the crude fibre content of extruded sample of different treatment of pasta as per formulation is in the range of 0.90 – 2.10g/ 100g. As per the study of (Zahrat *et al.*, 2016) studied that the value of crude fibre was 0.90 – 1.76g/ 100g.

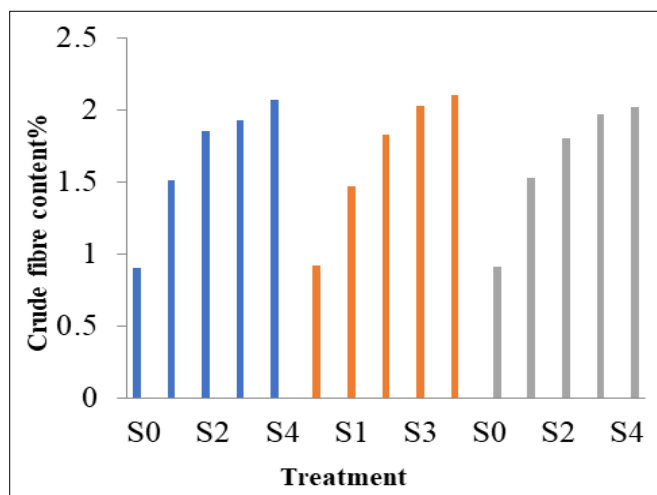


Fig 6: Effect of Crude fibre content on different treatment of beetroot pasta.

Table 6: Fat content of incorporated beetroot pasta.

Treatment	Fat (g)
T ₁ S ₀	0.71
T ₁ S ₁	0.89
T ₁ S ₂	1.10
T ₁ S ₃	1.29
T ₁ S ₄	1.58
T ₂ S ₀	0.69
T ₂ S ₁	0.87
T ₂ S ₂	1.05
T ₂ S ₃	1.30
T ₂ S ₄	1.53
T ₃ S ₀	0.72
T ₃ S ₁	0.88
T ₃ S ₂	1.09
T ₃ S ₃	1.25
T ₃ S ₄	1.59

Difference in Fat content of different treatment of incorporated beetroot pasta

One strategy frequently used for weight reduction is to eat foods low in caloric density, biologically due to high percentage of carbons in fats; they stored nutrient with the highest energy or calorific value of food constituents. The fat content of extruded sample was in the range of 1.25 – 2.95g/ 100g was studied by (Mounika *et al.*, 2018). The fig. shows the difference in fat content of different treatments of beetroot pasta 0.89 – 1.14g/ 100g. The (Zahrat *et al.*, 2016) studied show that there is some difference in fat content as 0.96 – 1.06 g/ 100g.

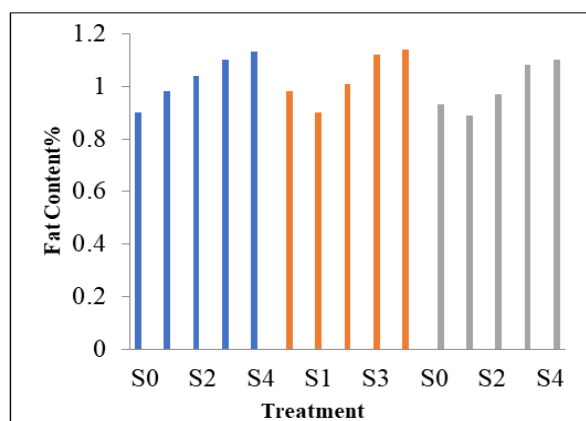


Fig 7: Effect of fat content on different treatment of beetroot pasta.

Table 7: Carbohydrate content of incorporated beetroot pasta.

Treatment	Carbohydrate (g)
T ₁ S ₀	76.98
T ₁ S ₁	75.8
T ₁ S ₂	75.14
T ₁ S ₃	74.75
T ₁ S ₄	73.91
T ₂ S ₀	76.89
T ₂ S ₁	75.95
T ₂ S ₂	75.4
T ₂ S ₃	74.66
T ₂ S ₄	73.99
T ₃ S ₀	76.86
T ₃ S ₁	75.85
T ₃ S ₂	75.47
T ₃ S ₃	74.83
T ₃ S ₄	73.89

Difference in carbohydrate content of different treatment of incorporated beetroot pasta

Carbohydrate provides major source of energy in human diet, in the pasta product carbohydrate content in different treatment and different formulation in the range of 73.89 – 76.98%. The previous study was show that the carbohydrate content was in the range of 72.1 – 82.98%. (Mounika *et al.*, 2018)

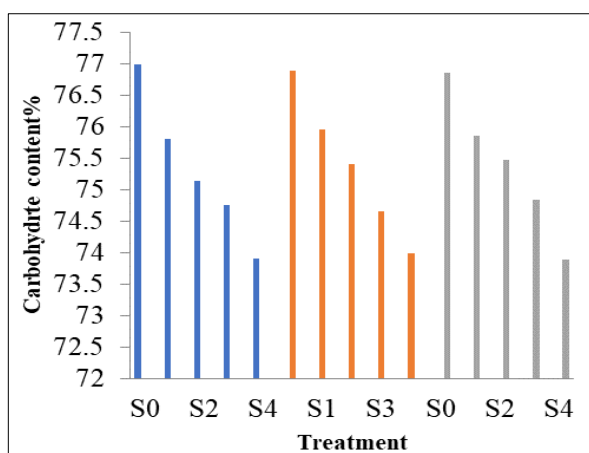


Fig 8: Effect of carbohydrate content on different treatment of beetroot pasta

Sensory analysis of incorporated beetroot pasta

Sensory analysis of incorporated beetroot pasta was done by 9-point hedonic scale.

The test was used for the product comparison and overall quality grading by sensory plane in score scheme for different quality attributes based on their relative importance contributing to overall product quality. In this case all parameters i.e., color, texture, flavor, aroma, and overall acceptability were given equal importance. Were as per the results there was no significant difference in overall acceptability of the sample tested. Sample T₃S₂ secure the highest score for overall acceptability (8.3) where T₂S₄ secure the lowest score (7) thus all the samples were equally acceptable and ranked as “like very much” while T₃S₂ secured the highest score for all attributes.

Conclusion

Fortified red beetroot powder incorporation has improved the nutritional value as well as accepted by sensory score. The pasta containing 20% beetroot powder the nutritional values found as moisture- 8.52%, ash- 1.09%, protein- 12.15%, crude fibre- 1.80%, fat- 0.97%, carbohydrate- 75.47%. Sensory evaluation by trend penalist has been found as color (8.5), flavor (8), texture (8.4), taste (8.5), and overall acceptability (8.3).

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