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Development and incorporation of *Pithecellobium dulce* (Camachile) fruit powder in multi grain pasta

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Abstract
Due to lack of awareness of *Pithecellobium dulce* and being an underutilized crop, very few investigations have been done on it of which it has been proved to be a very good source for nutraceuticals and anti-oxidants having a great potential to be used in medicinal and food purposes. Keeping this in view the aril powder was incorporated in the multigrain pasta. Owing to high sugar content and acidic nature, to prevent browning of the arils during the drying process, the arils are subjected to blanching and 0.5% KMS, 1% KMS and 1% Ascorbic Acid pretreatments, among which 0.5% KMS treatment is observed to produce a visually preferable color. Drying is carried out at 75 °C for 4 hours, followed which the arils are subjected to comminution for development of the powder with particle size 300µ. Chemical analysis after incorporation into the product proves the 10% camachile fruit powder to have higher content of ash, crude fiber and protein i.e. 5%, 3.5% and 7% respectively along with organoleptic overall acceptability of the product with a scoring rate of 6.5-7.5% thus indicating its successful utilization in convenience foods.

Keywords: Camachile, CPF, multigrain pasta, cooking quality

Introduction
India, a developing country and being the second most populous country in the world, the nation holds responsibility of feeding its 130-crore people. However, with increasing population pressure and improving standards of living human survivorship has become one of the biggest challenges for mankind with a threat for potential food and nutritional scarcity due to the apathetic exploitation of resources causing its depletion. This arises the need to search for alternatives, thus exploring the unexplored and utilizing the underutilized plant species. Manila Tamarind is one such fruit a large, nearly evergreen tree that grows up to 20 m or more in height. The fruit is exceptionally perishable leading to huge waste, since there is no preservation or value addition. These days a great number of desired properties are being incorporated today in various products by the process of extrusion in the form of convenient foods. Pasta is one such product manufactured using the technique. However, the addition of other grains in the product enhances the nutritive value of the wheat flour along with the taste and health benefits. Multigrain products do have many essentials that is required by the body for daily energy and fostering a sound, strong and fine fettle body. Taking all these points into consideration the following research was taken up with the objective of incorporating aril powder into multigrain pasta.

Material and Methods: The present study is conducted at Dr. NTR College of Food Science and Technology, Acharya N. G. Ranga Agricultural University, Bapatla, Guntur Dist., Andhra Pradesh.

Camachile fruit: The fresh raw and matured camachile fruits used for the study are obtained by directly plucking the fruits from the trees that grow in the area i.e., Bapatla, Guntur Dist., Andhra Pradesh. Fresh, healthy, raw, ripe and defect free fruits are then sorted out manually and selected for the study. The fruits are cleaned (removal of leaves, dirt etc.), peel and seeds removed and the arils are packed in LDPE pouches, sealed and stored at -18 + 5 °C.

Development of the product: Grains used for development of the multigrain pasta i.e. rice, green gram, bengal gram and sorghum along with wheat flour, oats, semolina, oil and salt are procured locally from the market of Bapatla, Guntur Dist., Andhra Pradesh.

The camachile fruit powder is obtained with 0.5% KMS treatment by drying at 75 ^{0}C for 4 hr selected for the experiment.

Experimental Design: This includes Procurement of ingredients - Processing of ingredients,
Development of the pasta samples (Control, T1, T2, and T3) - Quality assessment (cooking properties, proximate and sensory analysis).

Table 1: Formulation of the Composite Flour

Sr. No.	Ingredients	Quantity
1	Wheat Flour	500 g
2	Oats	250 g
3	Rice	250 g
4	Semolina	100 g
5	Bengal Gram Dal	50 g
6	Green Gram Dhal	50 g
7	Sorghum	50 g

The basic formulation of the composite flour for preparation of multi-grain pasta incorporated with camachile fruit powder is presented in table 1. The multigrain flour composition is kept constant; however, the camachile fruit powder content is increased in the samples T_1, T_2 and T_3 respectively. The flour content is decreased gradually in the samples Control, T_1, T_2 and T_3 respectively. The camachile fruit powder is increased gradually at the rate of 10%, 20% and 30% in the sample T_1, T_2 and T_3 respectively (Table 2.).

Table 2: Formulation of the multi-grain flour incorporated with Camachile Fruit Powder

Ingredients	Control	T_1	T_2	T_3
Multi-grain Flour	200 g	180g	160g	140g
Camachile Fruit Powder	0g	20g	40g	60g
Salt	4g	4g	4g	4g
Oil	10mL	10mL	10mL	10mL
Water	106mL	108mL	112mL	118mL

Methodology opted for preparation of multigrain pasta incorporated with CPF

Processing of selected grains: Rice, Bengal gram dal, green gram dal and sorghum are cleaned to remove the dirt, dust and foreign matter by winnowing. These grains along with semolina are roasted for 5 min separately for flavour enhancement. The roasted grains and oats are weighed and subjected to milling in hammer mill.

Preparation of composite flour: The fine flour obtained from milling is mixed with the wheat flour in the ratio as formulation procedure as mentioned in Table 2. Four Samples (Control, T_1, T_2, and T_3) are prepared with sample control containing only multi-grain composite flour (100%), while sample T_1, T_2, and T_3 are prepared using different concentration of composite flour and camachile fruit powder. Concentration of different raw materials taken in the preparation of Control and other samples (T_1, T_2, and T_3) is shown in Table 2. All the samples are sieved thrice to improve the mixing. Prepared samples are stored in LDPE pouches at 4°C for further study.

Pasta Preparation: The Doughs are prepared by combining flours, salt, oil and water. The addition of water is the most crucial part in the preparation of dough. According to Schoenlechner *et al*. (2010) [11], the dough moisture is an important parameter because it has an influence on pasta quality; if the dough moisture is too high, the pasta will be too sticky and they will disintegrate during cooking.
The doughs are prepared as per the formulation described in Table 2. The dough is kneaded for 10 min and kept aside for resting for 15 min at ambient temperature. Dough resting, helps water penetrate into dough particles evenly, protein mellows and becomes more extensible resulting in a smoother and less streaky dough after sheeting. After resting, the dough is subjected to sheeting using the sheeting rolls of Biltek Pasta Maker Roller Machine (HOM-012) with the adjustable thickness 4 to form the dough sheet. The sheets are then compounded and passed through the sheeting rolls again. This process is repeated for 3 times. The sheet is then cut into pasta strands of desired width of 4.5 mm by using the cutting blades of the equipment. These strands of the pasta are then manually separated with flour in aid and subjected to steaming for 10 min. The final pasta samples are subsequently dried using tray dryer at 70 °C for 4 hours. Thenceforth the dried samples are cooled and packed in LDPE pouches for further studies. Based on the thickness, it is concluded that the prepared pasta is Fettuccini.

Plate 1: Final product samples after drying

Assessment of cooking quality of formulated pasta

Optimal cooking time: The optimal cooking time (OCT) is determined according to the AACC Approved Method 66-50, where 5-g dried pasta samples are boiled in 200mL of distilled water. Each 30 s, a pasta strand is removed from boiling water and squeezed between two glass plates. Samples are considered cooked when the center white core disappeared.

Water absorption and cooking loss: Water absorption (WA) and cooking loss (CL) are determined according to the AACC Approved Method 66-50. 10g dried pasta samples are pre-weighed and boiled in 300mL of water during the cooking time previously determined. Then, samples are removed and weighed. The weight difference before and after cooking is used to calculate the water absorption.

Calculation

WA (%) = CPW-DPW/DPW X 100

Where
CPW = cooked (wet) pasta weight (g)
DPW = dried pasta weight (g)
Solids particles that diffuse from pastas into the cooking water are known as Cooking Loss. CL was measured by putting cooked pasta in an oven at 50°C for 48 h (using the same units as described previously):

CL (%) = DPW - OPW/DPW X 100

Where, OPW = Oven dried pasta weight (g)

Proximate analysis of formulated pasta
Moisture Content: Moisture content is estimated using air oven drying method by placing about 2-5 g of sample for 24 h in a hot air oven (Model KOMA 3) maintained at 103 + 1 °C (FSSAI,2012) [4].

Other proximates: The fat content of the sample is determined by semi-continuous soxhlet method using soxhlet apparatus (Model SCS 4). Crude protein of the sample is estimated using micro kjeldahl method. The ash content is determined using AOAC Official Method 2000. Crude fibre is estimated using AOAC Official Method 2005. The carbohydrate content of the sample on dry weight basis is calculated by difference method (Jain and Mogra, 2006) as given below: Carbohydrate (g/100g) = 100 – (moisture + crude fibre + ash + protein + fat).

Sensory evaluation: The acceptability of developed multi-grain pasta incorporated with CFP is evaluated by a testing panel through sensory evaluation. The nine-point hedonic scale rating is used to determine the acceptability. The samples are cooked in boiling water for fifteen min. Then the pasta samples are allowed to drain through a strainer for 5 min and it is tempered with equivalent amount of oil, salt, pepper and certain vegetables (capsicum, carrot and tomato puree). Samples are coded and served to sensory panel including 5 male and 5 female semi trained candidates in the age group of 21-50 years for sensory evaluation. They are instructed to evaluate the four samples with regard to given sensory characteristics such as colour, taste, flavour, texture and overall acceptability and to indicate the perceived intensity of the specified characteristics by giving the appropriate number related to the 9-point hedonic scale.

Statistical analysis: Statistical analysis is performed using the MINITAB® statistical software version 19.0.1. Data were analyzed using one-way analysis of variance (ANOVA) with three replications i.e., n=3.The data in the tables are mentioned as Mean + Standard Deviation. Post-Hoc Tukey's Honestly Significant Difference Test is done at 5% level of significance and 95% confidence i.e., $p < 0.05$. The Tukey's paired comparison test helps in grouping of the data and finding out statistically significant difference among them. The mean values in a row that do not share the same superscript are significantly different at $p < 0.05$.

Moisture content: The moisture content of the control sample is significantly different from the test samples i.e., 11% while the test samples have the same level of moisture content i.e. 8%. Thus, the product might have a longer shelf life due to reduced moisture content.

Crude protein
The control sample is observed to have the least amount of protein content i.e., 1.75% + 0.001. However, the protein content in the test samples are significantly different from each other i.e. T_1, T_2 and T_3 have 7.01% + 0.002, 5.25% + 0.001 and 3.52% + 0.025 of protein respectively. Thus, the lowered protein content product can be consumed by people suffering from kidney and liver diseases.

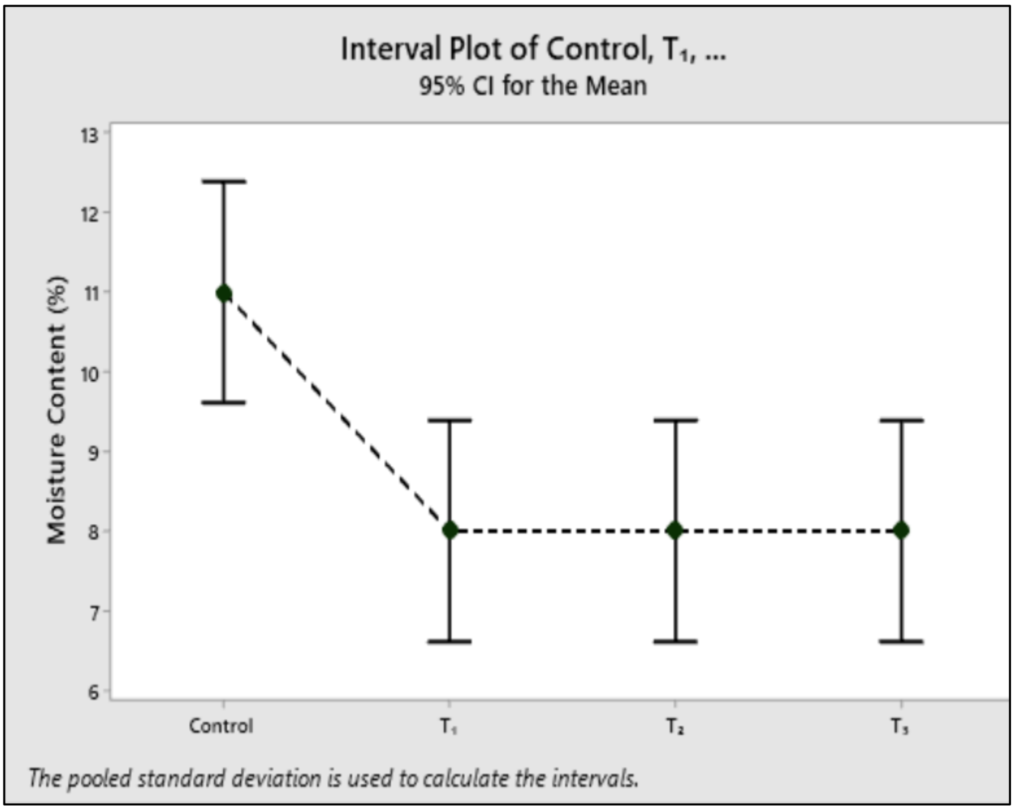

Fig 1: Interval Plots for Moisture Content

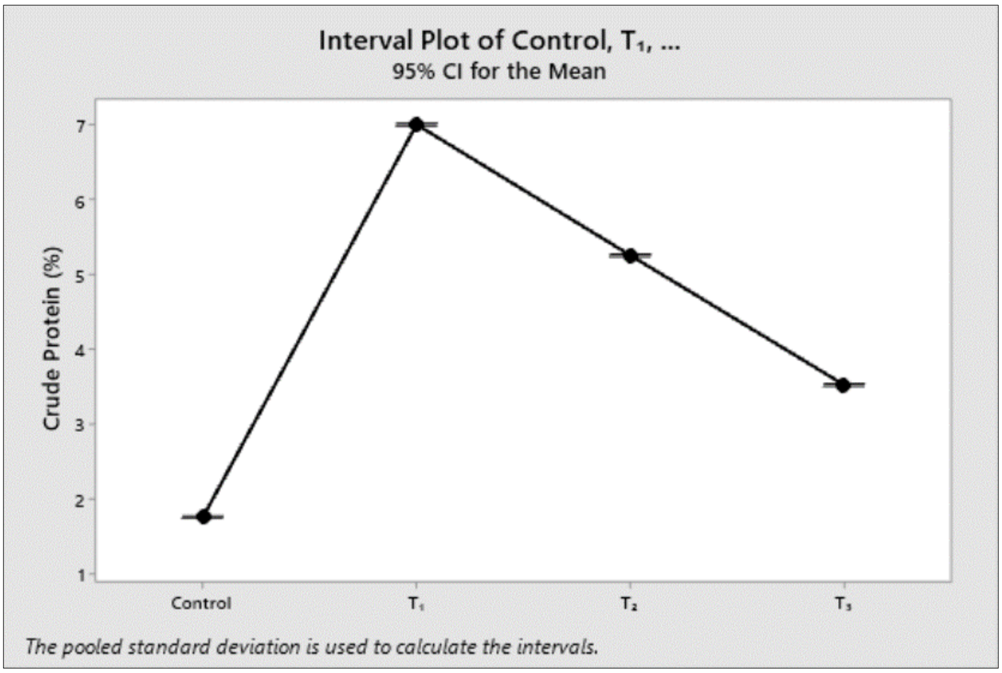

Fig 2: Interval Plots for Crude Protein Content

Crude fat

The fat content is observed to be highest in the control sample i.e., 1.42% + 0.204 and is not significantly different from that of in T_3 i.e., 1.22% + 0.138 but they are significantly different from the fat content in T_1 and T_2 i.e., 0.41% + 0.012 and 0.62% + 0.154 respectively. The values are similar to the fat % reported by Jalgaonkar *et al*. 2016 who has developed pearl-millet based pasta as a functional food.

Crude fibre: A reducing trend is observed in the content of dietary fibre in the test samples i.e., T_1, T_2 and T_3 have 5.01% + 0.023, 4.51% + 0.01 and 3.02% + 0.021 respectively. 4.01% + 0.015 of crude fibre is determined in the control sample. Jaya Tripathi *et al*. 2015 has developed a ragi pasta which has much lowered value of ash i.e., 1.57-1.76%., thus indicating that the developed pasta can be a better choice to people those who want to reduce their weight and prevent diabetes.

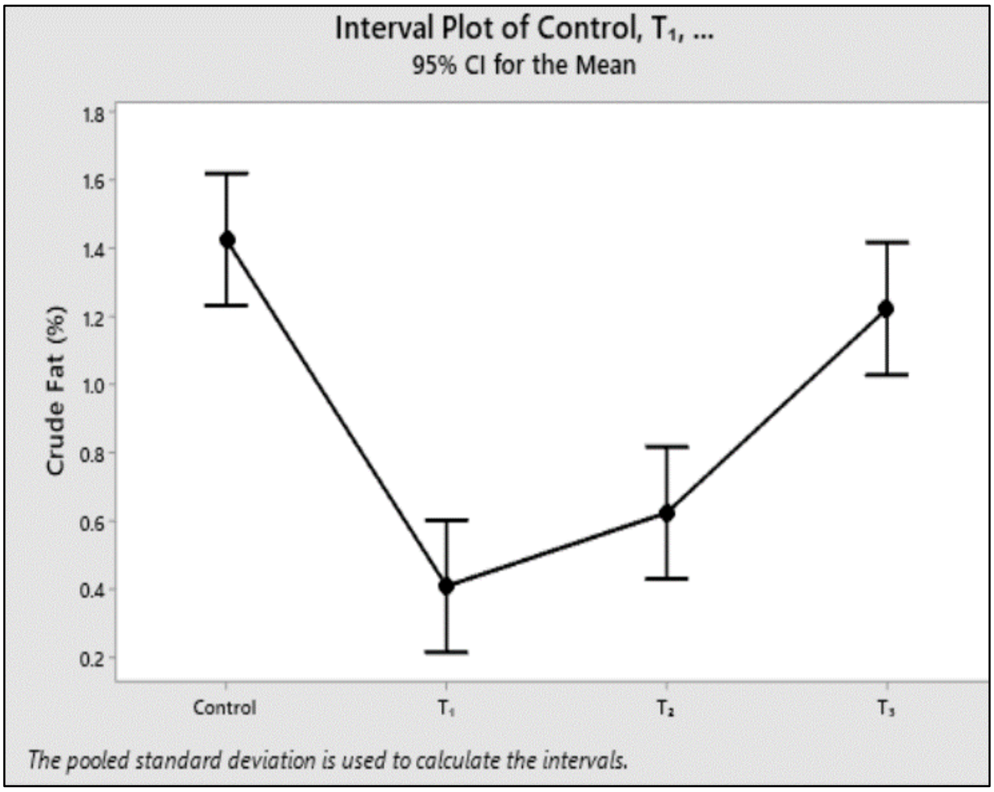

Fig 3: Plot for Crude Fat

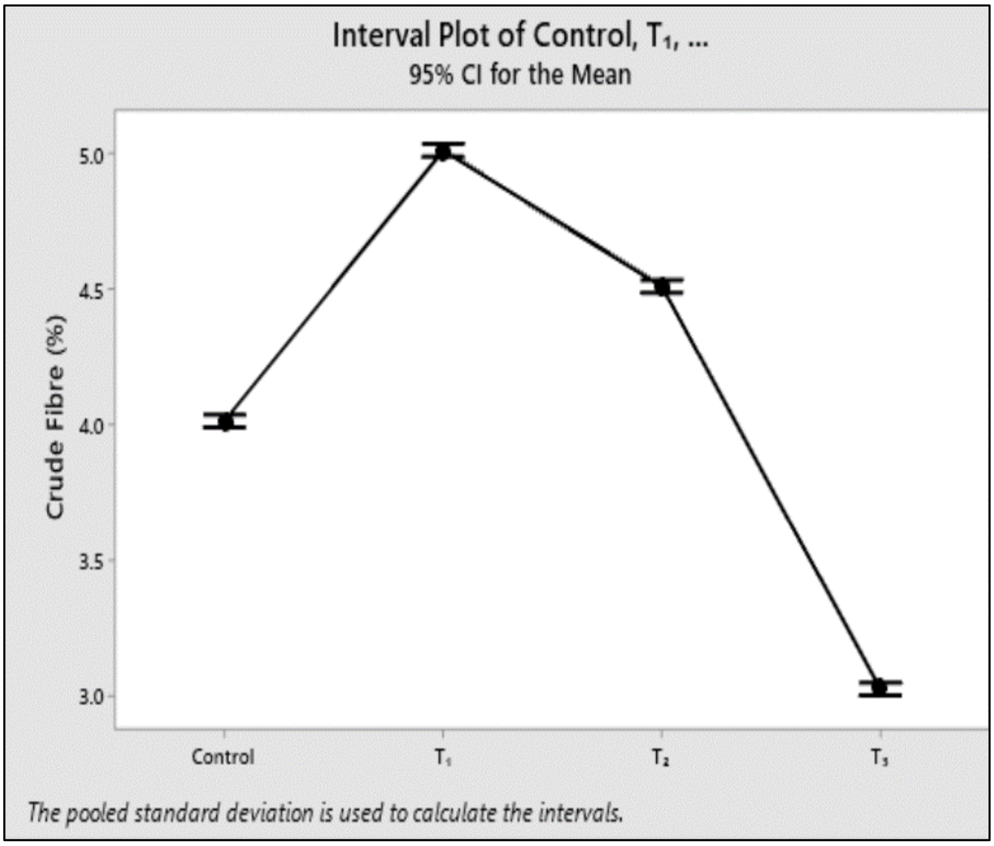

Fig 4: Plot for Crude Fibre

Ash Content: 3.61% + 0.01, 3.42% + 0.0153 and 3.21% + 0.006 ash is obtained in the test samples T_1, T_2 and T_3 indicating a decreasing trend. The content of ash is further reduced in control sample i.e., 2.61% + 0.023. Piyush Mishra *et al*. 2016 [16] has reported almost similar % of ash content in the 'Study on Development of Fortified Pasta with Ginger Powder'. The acceptable sample has 3.08% ± 0.04 ash content in it.

Carbohydrates and Energy: The carbohydrate content in the samples is not significantly different from each other at 5% level of significance with the highest value observed in T_3 sample providing a comparatively higher amount of energy i.e., 83.72% + 4.61 and 323.45 kcal respectively. An increasing trend is observed in producing energy by the sample because of increasing carbohydrate content from T_1 to T_3. the control sample is observed to have 82.79% + 6.47 and 315.84 kcal carbohydrate and energy respectively. The reported values of carbohydrates are comparatively higher than that reported by Harsimrat Kaur, 2014 who has developed a multigrain pasta with the carbohydrate % ranging from 60-78%.

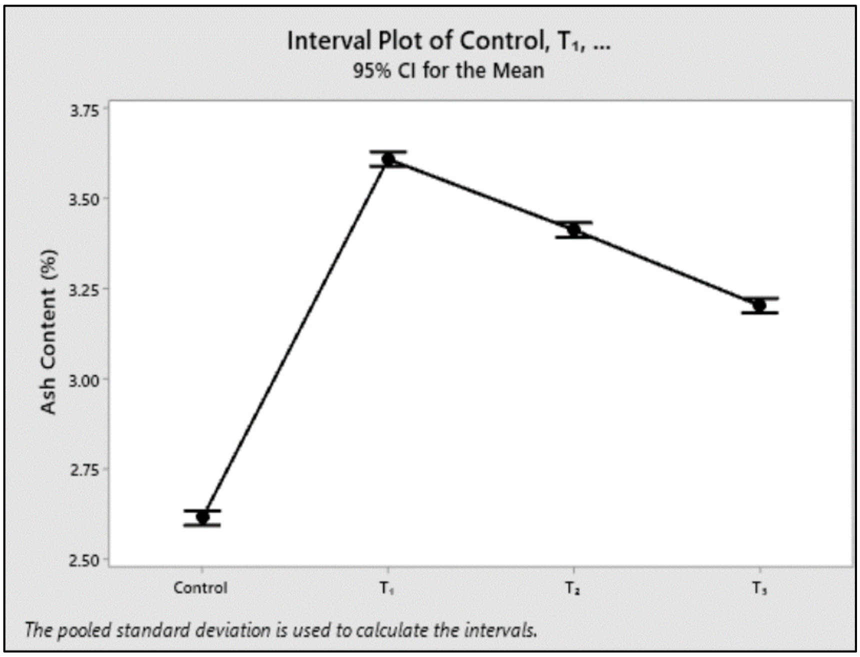

Fig 5: Plot for Ash content

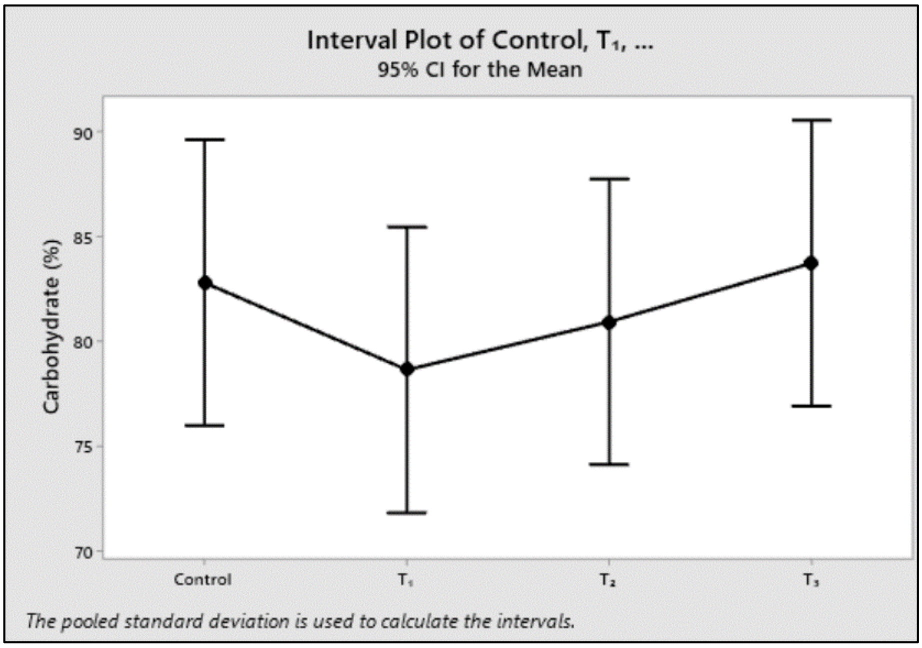

Fig 6: Plot for Carbohydrate Content

Table 4: Cooking Characteristics of the formulated pasta

Cooking Characteristics	Control	T_1	T_2	T_3
Optimal Cooking Time (min)	22	13	15.5	17.5
Water Absorption Capacity (%)	100	135	128	112
Cooking Loss (%)	11	131	14	17

The optimal cooking time is observed to increase with increase in concentration of the fruit powder i.e., T_1, T_2 and T_3 samples take 13, 15.5 and 17.5 min to cook. The control sample takes longer time to cook i.e., 22 min. The trend observed might be due the high gelatinization temperature of the flours due to the possibility of lower starch content in the flours.

Percent WAC is found to be highest in the T_1 sample *viz*. 13 % while the control sample has only 100% WAC. According to Sarah *et al*., 2017, the pasta WAC between 100-200% is acceptable. Our samples range between 100 and 135%, so we can say that they were all acceptable because there were all between 100 and 200%. 17% Cooking loss is recorded highest for T_3 sample and a declining trend is observed with the least being in the case of control sample i.e., 11%. This might be due to reduction in binding agents of flour with increasing incorporation % of the fruit powder. The fruit powder might have poor adhesive properties. There might be leaching of the soluble starch as well as other solid components that have caused rise in the Solid loss (or) cooking loss.

Sensory evaluation of the developed product

Table 5: Scores for the Pasta samples given by panel members during sensory evaluation

Attributes	Control	T_1	T_2	T_3
Colour	7.5 + 0.527a	6.6 + 0.699b	6.5 + 0.527b	6.4 + 0.966b
Appearance	7.7 + 0.483a	7 + 0.471ab	6.8 + 0.632b	6.3 + 1.16b
Taste	6.9 + 0.994a	6.8 + 1.033a	6.5 + 0.85a	6.6 + 0.966a
Flavour	6.4 + 0.699a	6.9 + 0.994a	6.8 + 0.632a	6.4 + 1.174a
Texture	7.3 + 0.483a	7 + 0.471ab	6.8 +0.422ab	6.4 + 0.966b
Overall Acceptability	7 + 0.816a	7.1 + 0.667a	6.5 + 0.527a	6.3 + 1.16a

The mean values in a row that do not share the same subscript are significantly different at $p < 0.05$ (Here n = 10)

A declining drift is observed for the scores of colors of the pasta sample, the highest being recorded for the control sample i.e., 7.5 + 0.527 and the lowest for T_3 i.e., 6.4 + 0.966. This might be due the maillard reaction of the fruit powder within the pasta sample. Many researchers have stated rich anti-oxidant property of the fruit. These anti-oxidants have the tendency to discolor the food. This might be the reason of discoloration of the product here as well. This also influences the appearance of the product which is visible in the scoring of the sensory panel who have given least score of 6.3 + 1.16 to the T_3 sample and highest to the control sample i.e., 7.7 + 0.483.

The taste of the control sample is liked the most receiving a score of 6.9 + 0.994. With increase incorporation of camachile fruit powder with the composite flour in pasta formulation, the sensory score for flavor decreased. Highest flavor scores are recorded by T_1 sample *viz*. 6.9 + 0.994 indicating the camachile flavor is liked by the panelists in comparison with the pasta prepared only with multi-grain composite flour (6.4 + 0.699). The scoring for texture is noted to have a decreasing trend from control to T_3 sample indicating that the incorporation of the fruit powder has a negative impact on the texture of the product. Sensorial data reveals that OAA of pasta decreases with increasing incorporation of fruit powder in the formulation of pasta. OAA of the T_1 sample is recorded with highest score of 7.1 + 0.667 as compared to 7 + 0.816 for the control sample. Thus, based on the scores for different parameters of the formulated product it is concluded that T_1 sample is the best acceptable sample *viz*. incorporation of camachile fruit powder at 10% in the multigrain pasta.

Conclusion

The formulated product is a good source of dietary fiber; the highest content being observed in the 10% CFP incorporated sample *viz*. 5.015% + 0.023. It is also rich in minerals that can be observed with higher value of ash of 3.61% + 0.01. The 30% CFP is noted to provide highest amount of energy i.e., 323.45 kcal. The cooking time of the pasta is very high ranging from 12 min to 23min and cooking characteristics indicate 10% CFP in the multigrain pasta to be ideal.10%

CFP incorporation in pasta is acceptable by the sensory panelists based on organoleptic characteristics. Thus, it can be concluded that the neglected fruits in our nature can also be of great help. The manila tamarind is known to have high content of micronutrients and nutraceuticals and the fruit can be successfully exploited for the balanced diet of the individuals. The oil obtained might also act as an alternative source of biofuel. Software programmes can be developed for easy handling of the fruit thus, will aid in commercializing the fruit.

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