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COMPARATIVE EVALUATION OF NUTRITIONAL AND PUNGENCY QUALITIES OF SELECTED CHILLI CULTIVARS

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Chilli is a popular spice plant from the family Solanaceae. It is famous for pungency and is an indispensable part of our daily life, not only in India but all over the world. The place of origin of chilli is believed to be America. In pre-Colombian times capsicum was widely used in central and south America. Archeological evidences suggest that the Indians used to eat chillies as early as 7000 BC, although these were probably wild plants (Vaughan *et al*., 1997). Throughout the world chilli is consumed fresh, dried or powdered (El-Ghoraba *et al*., 2013). In world, area and productivity of chilli is around 20.20 million hectare and 37.62 million tons respectively. The largest producer of chillies in the world is India accounting for 13.76 million ton annually out of the total 37. 62 million ton global chilli production (Geetha *et al*., 2017). The present term 'chilli pepper' refers to varieties with small and spicy fruits, on contrary the term 'sweet pepper' refers to varieties with larger and little or no spicy (Tripodi and Sanjeet, 2019). The uniqueness of chilli is the typical pungency due to the presence of capsinoids, which are secondary metabolites and derived of phenylpropanoids produced in placental epidermis cell and accumulated in structures located on placenta surface (Stewart *et al*., 2007). Capsaicin and dihydroxy capsaicin are the two predominant compounds accounting for almost 90 percent of total capsinoids. Anti-inflammatory, anti-cancer and anti-obesity activities have been linked to capsinoids (Luo *et al*., 2011). In India, C. *annuum* and C. *frutescens* are the commercially most popular species of chilli. These are being used as food flavoring, a coloring agent, a pharmaceutical ingredient and in other innovative ways (Bosland, 1996). Regular conception of capsicum fruits is beneficial for vascular conditions and against hemorrhoids, varicose vein and liver congestion (Grubben *et al*., 2004). Chilies are indispensable part of the diet in all the states of India, especially Kerala. There are different types of domesticated chilies available in local markets of Kerala. But mostly used varieties comes under two species viz., *Capsicum annuum* and *C. frutescens*. The present study aims to compare the proximate composition and heat values of six commonly cultivated chillies and one commercially available chilli powder from Kerala.

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Preparation of sample

Samples were prepared with six different types of fresh chilli fruits, *i.e*., Bullet chilli, Piriyan chilli, Pacha chilli, Sambari chilli, Bajji chilli (*C.annuum* L.), Kanthari chilli (*C. frutescens* L.) and one commercially available chilli powder (MC) available in Kerala, India. The materials were washed thoroughly with double distilled water and shade dried for 10-12 days. Dried samples were powdered with the help of grinder and stored in airtight container, each sample was weighed and used for further analysis. Moisture, ash, fat and crude fibre contents were estimated by AOAC method (1998).

Moisture

Thermogravimetric analysis was used for the determination of moisture content. Five g of chilli fruits was taken in a porcelain dish and placed in an electric oven maintained at $105^0C \pm 2^0C$ for 5 hours. The dish was cooled in a desiccator and weighed. The process of heating and cooling in a desiccator was repeated until the differences in two successive weights was less than 1 mg.

Ash content

The crucible was heated to 550 ± 25^0C in a muffle furnace, and cooled in a desiccator (M0). Two g of the sample was weighed into a crucible (M1), and about 2ml of ethanol was poured on the material and ignited. The sample was kept inside the previously set muffle furnace and heated at $550\pm25\ ^0C$ until the ash was visibly free from carbon particles (2hrs). It was cooled and the ash was moistened with several drops of water, evaporated carefully to dryness and heated in muffle furnace for further 1 hour at $550\pm25\ ^0C$. The crucible was cooled in a desiccator and weighed (M2). The crucible was again heated for further 30 min., cooled and weighed. The content was worked out in the following way:

$$\text{Total ash (on dry basis) (g/100g)} = \frac{(M2-M0)}{(M1-M0)} \times 100$$

M2 =Mass in gram of the dish and total ash; M0 =Mass in gram of the empty dish; M1 =Mass in gram of the dish and test portion.

Protein

Kjeldahl (1883) method was used for determination of protein. One gram sample was weighed and put into the digestion flask. One g mercury oxide and 15 g powdered potassium sulphate and 25 ml sulphuric acid were added. Flask was placed in an inclined position on a heater and heated gently until foaming ceases. A small amount of paraffin or silicon antifoam was added to reduce foaming. It was vigorously until the solution became clear and then boiling was continued for 1 to 2 hours.

Fat

Fat content in the sample was determined by using Soxhlet method. 10g of sample was weighed, put in a thimble. The sample was dried in an oven at 100±20C for 2 hours. The sample was allowed to cool in a desiccator. The thimble was inserted in a Soxhlet extractor. A clean, dry 150 mL round bottom flash was weighed and about 90 mL of petroleum ether was put into the flask. The extraction unit was placed over a water bath and the solvent was heated in the flask until it boiled. The extraction was continued for 6 hrs. Traces of the residual solvent were removed by keeping the flask in the hot air oven for about 30 min.

Carbohydrates

Total carbohydrate content was calculated as Total Carbohydrates % = 100 – (A + B + C + D), where A = percentage by weight of moisture; B = percentage by weight of total protein; C = percentage by weight of fat; D = percentage by weight of total ash.

Crude fibre

The crude fibre was determined gravimetrically using chemical digestion after the residue was ashed and loss in weight was recorded as crude fibre.

Energy value

Energy value was calculated as Energy Value = (9 x fat%) + (4 x protein%) + (4x carbohydrate%).

Total sugar

Total sugar was calculated as per the procedure of FSSAI Lab manual 2015.

Capsaicinoids

The analysis of capsaicinoids was carried out by using High Performance Liquid Chromatography (Agilent Technologies 1200 infinity series). The elution was performed with a mixture of Acetonitrile: Water (60:40). Measurement was carried out at 280nm and the run time was 17 min. The flow rate was 1.0mL/Min and the column temperature was 40ºC. Injection volume was 20 µL. Standard used for the quantitative analysis was N-Vanillylnonanamide.

Nutrient analysis

Chillies are an excellent source of phytochemicals, provide many nutritional and health benefits that include anti-oxidants, anti-inflammatory, anti-microbial activities and these also reduce the prevalence of type 2 diabetes and obesity. It also protects against hyper cholesterolemia and reduces the risk of artheroscleritic cardiovascular diseases (Spiller *et al.*, 2008; Careaga *et al*., 2003; Alvarez *et al*., 2011). Different phytochemical composition patterns of six *Capsicum* cultivars and one commercial chilli powder indicated that apart from the morphological differences like shape and size, nutrient status and pungency are also important.

Moisture

Among the seven samples analysed, the highest moisture content was detected in Bajji Chilli (11.2%) followed by Sambari chilli (4.4%). The lowest moisture content was observed in MC (4.4%) (Table 1; Fig. 2). When compared with other studies, the moisture range varied from 9.43 % to 11.16 % in cultivars such as drum pepper, long chilli pepper and small chilli pepper (Emmanuel-Ikpeme *et al*., 2014), but it was 4.48 % in hot peppers (Yu Zou *et al*., 2015). The moisture range

Table 1. Proximate composition (%) of different samples of chillies.

Cultivar	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Carbo Hydrate (%)	Sugar (%)	Fibre (%)	Energy value (Kcal)
Bajji Chilli	11.2	10.8	20.59	1.61	55.73	1.46	31.7	319.77
Bullet Chilli	9.8	7.6	23.2	4.58	54.82	3.06	44.6	353.3
Kanthari Chilli	8.2	9.46	26.73	4.09	51.52	1.51	36.5	349.81
Sambari chilli	10.9	9.50	15.26	6.07	58.27	3.05	32.6	348.75
Pacha Chilli	9.2	6.83	17	4.98	61.99	2.82	22.5	360.78
Piriyan chilli	9.2	9.33	26.53	5.72	49.22	2.72	32.2	354.48
MC	4.4	6.78	24.46	13.99	52.37	14.7	25.0	425.23

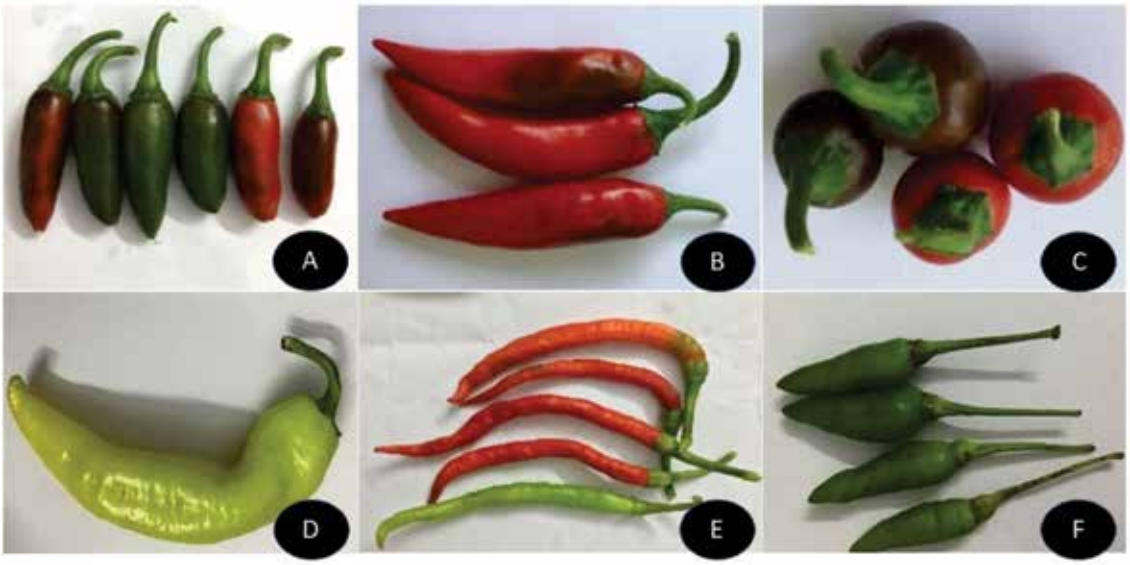

Fig. 1. A. Bullet chilli; B. Piriyan chilli; C. Pacha chilli; D. Sambari chilli; E. Bajji chilli; F. Kanthari chilli

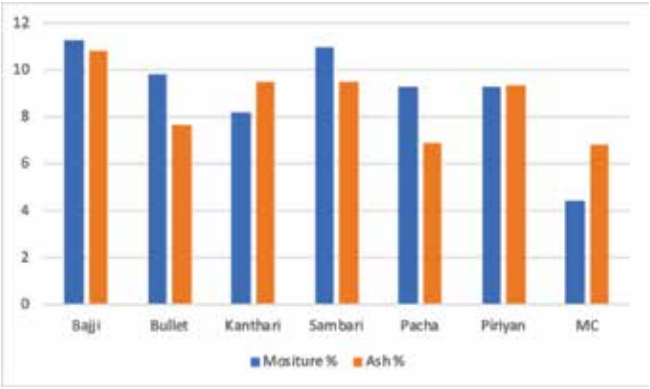

Fig. 2. Moisture and ash content (%) of different cultivars and market chilli

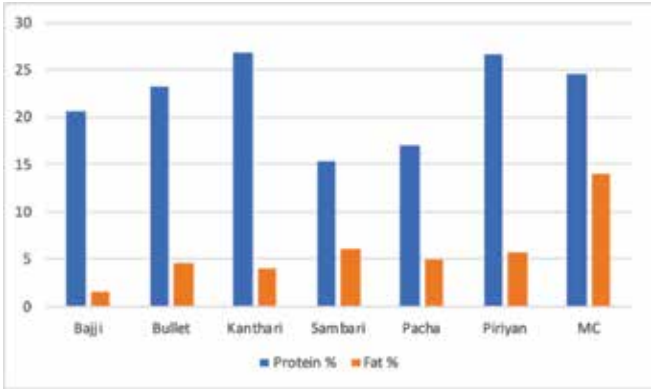

Fig. 3. Protein and fats content (%) of different cultivars and market chilli

was 8.7 % and 13.2 % in red pepper (Eun Ha Kim *et al*., 2019).

Ash

The highest ash content was noticed in Bajji Chilli (10.81 %) and the lowest ash content found in MC (6.78%) (Table 1; Fig. 2). The high ash content suggests the availability of minerals like sodium, calcium and phosphorous, etc in the fruits (Emmanuel-Ikpeme et al., 2014). The ash content varying between 3.03 % and 1.21 % in different chillies in Nigeria (Ogunlade et al., 2012). In hot pepper, it is 4.94 % (Yu Zou et al., 2015). Essayas et al., (2011) determined the ash content in chilies such as Marako fana (5.3%), Bako local (7.3%) and Oda haro (7.3%).

Protein:

As shown in Table 1, the highest protein content was found in Kanthari Chilli (26.73%) followed by Piriyan chilli (26.53%). Lowest protein content was found in Sambari chilli (15.26%) (Table 1; Fig.3). Plant proteins are high in non-essential amino acid and it is essential for vegetarian nutrition. It also enhances downregulation of insulin, up regulation of glucagon and prevents against cardiovascular diseases. (Krajcovicova *et al.*, 2005). Compared with other studies, the protein content varied between 9.6 % and 11.9 % in three pepper varieties of *Capsicum* (Emmanual *et al.,* 2014), 11.9 and 14.0 in *C. annuum* (Eun Ha Kim *et al.,* 2019) and 3.51% to 2.64% in four cultivars of *Capsicum* genus (Ogunlade *et al*., 2012). The protein content was in between 8.93% to 6.07% in 35 genotype of *Capsicum* analyzed by Nadra Khan *et al*. (2019).

Fat

The maximum fat was observed in MC (13.99%) and the lowest fat value was noticed in Bajji Chilli (1.61%)

Table 2. Pungency/heat values of different samples of chillies

Capsicum Cultivars	Heat Value (SHU)	Level of Pungency
Bajji Chilli	7443.55	Moderately pungent
Bullet Chilli	41337.65	Highly pungent
Kanthari Chilli	27484.09	Highly pungent
Sambari chilli	66297.56	Highly pungent
Pacha chilli	21856.79	Moderately pungent
Piriyan chilli	89379.5	Very highly pungent
MC	32484.36	Highly pungent

(Table 1; Fig.3). Fatty acids have great metabolic and structural importance and about 25 different types of fatty acids have been identified from the pulp and seeds of genus *Capsicum* (Sora *et al.,* 2015). Similar studies showed that fat content of three cultivars of Capsicum ranged from 0.35% and 1.75% (Emmanual *et al*., 2014), 9.2 % to 11.2 % in *C.annuum* (Essayas *et al*., 2011) and 23.65% in hot peppers (Yu Zou *et al*., 2015).

Carbohydrates

Seed ovaries are reported to contain highest amount of sugar and starch (Aloni *et al*., 1996). Highest value of carbohydrate was found in Pacha chilli (61.99 %) and the lowest in Piriyan Chilli (49.22%) (Table 1; Fig. 4). Similar studies showed that the highest amount of carbohydrate was found in Nigerian Capsicum (62.33%) (Tambuwal *et al*., 2018), and 56.63% in red pepper (Bahare *et al*., 2018).

Total sugar

Sugar content is higher in commercially available market chilli (14.7%). Lowest sugar content was observed in Bajji chilli (1.46%). In *Capsicum annuum* (hot), 5.3% total sugar has been reported (Tomi *et al.,* 2018) (Table 1; Fig. 4).

Crude fibre

Capsicum is a good source of crude fibre (Sharma *et al*., 2017). Fibre content is higher in Bullet Chilli (44.6%). Lowest fibre content was observed in Pacha chilli (22.5%) (Table 1; Fig.4). Yu Zou *et al*. (2015) showed that the highest crude fibre was 38.76 % in hot peppers. Fibre content in Ethiopian pepper was 26.0% to 28.6% (Essayas *et al*., 2011).

Energy value

The highest energy value was found in MC (425.33 Kcal) and the lowest value was found in Bajji Chilli (319.77 Kcal) (Table 1; Fig. 5). A similar result was indicated by Bahare *et al.* (2018).

Heat value analysis

Capsaicinoids are the compounds responsible for the pungency of the capsicum fruits (Othman *et al*., 2011). The two major capsaicinoids are capsaicin and dihydro capsaicin. This active molecule is only found in *Capsicum* and used in medical, food science as well as in defence weapon industry (Lee *et al*., 1996). It is abundantly seen in placental tissues and cross walls of the fruits (Grubben and Mohamed, 2004). The amount of capsaicin has been the measure of the pungency of

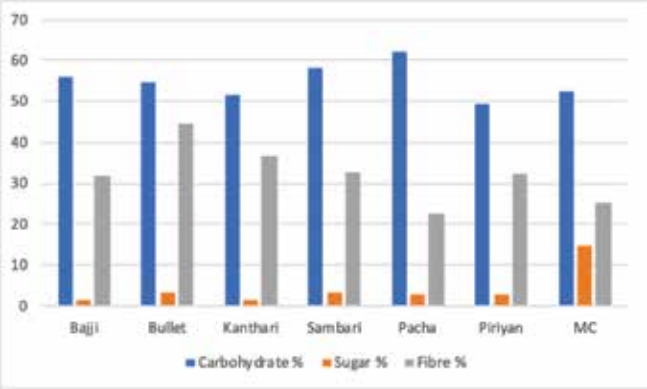

Fig. 4. Carbohydrate, sugar, crude fibre (%) of different cultivars and market chilli

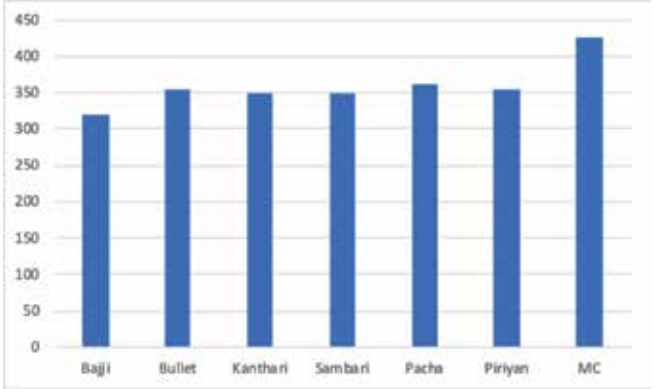

Fig. 5. Energy value (Kcal) of different cultivars and market chilii

chillies and generally expressed in Scoville Heat Unit-SHU (Scoville, 1912). There are 5 levels of pungency classified using SHU: non-pungent (0~700 SHU), mildly pungent (700~3000 SHU), moderately pungent (3000 ~25000 SHU), highly pungent (25000~70000 SHU) and very highly pungent (>80000 SHU) (Weiss, 2002). Out of the seven samples investigated, the capsaicinoids composition was highest in piriyan chilli (89379.5 SHU) followed by sambarii chilli (66297.56 SHU). The lowest heat value was estimated in Bajji chilli (7443.55 SHU) (Table 2)

It can be concluded that most widely used and commonly available market chillies in Kerala are good source of nutrients and adequate level of these nutrients is retained even after drying. The present study revealed the proximate composition and heat value of six cultivars of *Capsicum* and one commercially available market chilli in Kerala. The pepper cultivars contain substantial number of phytochemicals. The analysis of capsaicinoids indicated that Piriyan chilli is the hottest chilli in Kerala. The present information may be helpful for breeders to select better parents in the development of new cultivars.

Authors' contribution

Conceptualization and designing of the research work (SVK, AR); Execution of field/lab experiments and data collection (AR); Analysis of data and interpretation (SVK, AR); Preparation of manuscript (SVK, AR).

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