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Quality traits of Indian peanut cultivars and their utility as nutritional and functional food

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ABSTRACT

Peanut (*Arachis hypogaea* L.) is considered as a highly nutritious foodstuff. Of late, the importance of peanut as a functional food has been growing. Kernels of forty-one Indian peanut cultivars were analyzed for their oil, fatty acid profiles, sucrose, raffinose family oligosaccharides (RFOs); phenolics, and free amino acids contents along with antioxidant capacity. The range and the mean value (given in parenthesis) for each of the traits analysed were, oil: 44.1–53.8% (50.1%), O/L ratio: 0.9–2.8 (1.4), sucrose: 2.61–6.5% (4.63%), RFOs: 0.12–0.76% (0.47%), phenolics: 0.14–0.39% (0.23%), free amino acids: 0.052–0.19% (0.12%) and antioxidant capacity: 1.05–6.97 (3.40) μmol TE g^{-1}. The significant correlation between phenol content and antioxidant capacity suggests phenol content as an easy marker for rapid screening of genotypes for their antioxidant capacity. A few cultivars with desirable traits and their prospective utility were identified which would be useful for future breeding programme to develop nutritional superior peanuts.

1. Introduction

Peanut (*Arachis hypogaea* L.) is an important food as well as an oilseed crop of the tropical and sub-tropical world. As a rich source of energy (564 kcal 100 g^{-1}), it contains about 48–50% oil, 25–28% proteins and 20–26% carbohydrates. Among oilseeds peanut is unique in that it can be consumed directly as a foodstuff. Peanut kernels also contain many health enhancing nutrients such as seven of the 20 essential minerals; 13 essential vitamins particularly vitamin E, folic acid and niacin; and antioxidants. Peanut is a source of dietary biologically active polyphenolics, flavonoids, and isoflavones such as p-coumaric acid and resveratrol (Francisco & Resurreccion, 2008). The beneficial effects of phenolic compounds have been attributed to their antioxidant capacity (Heim, Tagliaferro, & Bobilya, 2002). The interest in the naturally occurring antioxidants is growing as they are natural compounds and in most cases are derived from plant sources and thus are presumed to be safe. For these reasons, many studies have been carried out to find out potential antioxidant capacity of compounds from natural sources (St. Angelo, 1996). Moreover, peanuts are rich in mono-unsaturated fatty acids and do not contains tarns-fatty acids (Sanders, 2001). Thus the consumption of peanuts elicits several biological effects such as weight-loss (Alper & Mattes, 2002), prevention of cardiovascular diseases by lowering blood pressure and blood cholesterol levels (Lopes, Costa, Gimenes, & Silveira, 2011), protection against Alzheimer disease, anti-inflammatory effects (Higgs, 2003), and inhibition of cancer (Awad, Chan, Downie, & Fink, 2000). Hence, peanut is gaining importance as a functional food besides being an oilseed crop. In Europe as well as North and South Americas, about 75% of the peanut produced is used as a foodstuff (Birthal, Rao, Nigam, Bantilan, & Bhagavatulu, 2010). In India too, the direct consumption of peanut has been growing and its food value is being increasingly realised due to availability of other edible oils at economical prices. During the 1980s, 81% of the total peanut produced in the India was crushed for oil expulsion and only 6% was used for direct consumption. In recent years, however, nearly half of the produce in India is used for direct consumption especially as value-added products like roasted peanuts, boiled peanuts, roasted and salted peanuts, peanut-candy, peanut-butter (Govindaraj & Jain, 2011). High levels of sucrose, oleic acid and antioxidant capacity and low levels of raffinose family oligosaccharides (RFOs; like raffinose, stachyose and verbascose) and oil are the considered desirable attributes in peanuts for value-additions. Sucrose and RFOs are the major soluble carbohydrates of peanut kernels (Bishi et al., 2013). The RFOs in food pass undigested through the stomach and are fermented by anaerobic bacteria in the lower intestine which causes flatulence besides discomfort and diarrhoea in humans and other monogastric animals (Tahir, Baga, Venberg, & Ravindra, 2012). Thus low RFOs content in peanuts is highly desirable. Various processing methods such as soaking, germination, partial fermentation and

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treatment with α-galactosidase have been suggested (Vidal-Valverde et al., 2002) to lower the RFOs contents. These processing methods, however, are not only time-consuming and uneconomical, but also cause loss of nutrients and raise consumer acceptability issues. Development of new cultivars with low RFOs contents would therefore be an effective approach to improve nutritional as well as functional quality of peanut.

In India, so far more than 194 peanut varieties have been released yet but only about 40 varieties are being currently grown in various parts of the country (Directorate of Groundnut Research. State-wise list of most promising groundnut varieties, 2014). India, besides being the second largest producer of peanut in the world is also the fourth largest exporter of shelled peanut (FAOSTAT, 2013). The country has exported nearly 535637 MT of peanut worth Rs. 4065 crores during the year 2012–13 (APEDA, 2012). Owing to comparatively poor physical as well as chemical quality of bulk of the produce, the export from India, however, is destined more towards countries like Indonesia, Malaysia, Thailand, Ukraine, Pakistan, etc. as bird feed rather than for food purpose to EU countries. The present investigation was therefore considered necessary and was aimed at generating information on certain quality attributes such as contents of oil, free amino acids, and total phenolics; profile of fatty acids and sugars; and also antioxidant capacity among forty-one popular peanut cultivars of India for use by the exporters as well as by the researchers engaged in improving the quality of Indian peanut.

2. Materials and methods

2.1. Experimental material

Kernels of the forty-one popular peanut cultivars in India belonging to different habit groups were collected from the Germplasm Resource Section, Directorate of Groundnut Research (DGR), Junagadh (Table S1, as Supplementary data). All the samples were derived from the plants grown under standard recommended procedures in 2011 rainy season i.e. kharif at DGR farm. After post harvest curing, the kernel samples were stored at 10 °C until used.

2.2. Extraction of antioxidants and analysis

Extracts for antioxidant capacity from the kernel was prepared by the method described by Thaipong, Boonprakob, Crosby, Cisneros-Zevallos, and Byrne (2006), with minor modifications. Pulverized kernel samples (1 g) were homogenised in a mortar with pestle in 25 ml absolute methanol. The homogenates were kept at 4 °C for 12 h and then centrifuged at 15,000 rpm for 20 min at 4 °C. The supernatants were transferred to 100 ml volumetric flask and pellets were re-dissolved in 25 ml absolute methanol and then centrifuged at 15,000 rpm for 20 min at 4 °C and pooled with the first extract. Total volume of extracts were made up to 100 ml with absolute methanol and stored at −20 °C until analysis. $ABTS^{\cdot+}$ radical-scavenging activity of peanut kernel extracts was determined according to Arnao, Cano, and Acosta (2001) with minor modifications. The stock solutions included 7.4 mM $ABTS^{\cdot+}$ solution and 2.6 mM potassium persulfate solution. The working solution was then prepared by mixing the two stock solutions in equal quantities and allowing to react for 12 h in the dark at room temperature. The solution was then diluted by mixing 1 ml $ABTS^{\cdot+}$ solution with 60 ml methanol to obtain an absorbance of 0.900 ± 0.020 at 734 nm using a spectrophotometer. Fresh $ABTS^{\cdot+}$ solution was prepared for each assay. In a 3 ml reaction mixture, 5 times diluted 100 μL of kernel extracts (2 mg/ml) were mixed in 900 μL of absolute methanol and allowed to react with 2 ml of the $ABTS^{\cdot+}$ solution for 30 min in dark. Then the decrease in absorbance was measured at 734 nm using the spectrophotometer. The standard curve was linear between 1 and 10 μM Trolox. Results are expressed in mM Trolox equivalents (TE)/g peanut.

2.3. Estimation of oil content

Oil content of subsamples was determined by Soxhlet method as outlined by Misra, Mathur, and Bhatt (2000). Kernels were ground to fine meal and weighed quantity (approx. 2.5 g) of meal was transferred to thimble and extracted in 150 ml hexane in an automated Soxhlet extraction assembly for 6 h. The solvent was then evaporated first on sand bath and subsequently in an oven at 60 °C to a constant weight. The values of oil were calculated and expressed as percent (w/w).

2.4. Fatty acid analysis

The fatty acids were analysed by preparing methyl esters. In a 10 ml screw cap test tube, 200 μl oil was mixed with 3 ml hexane kept for 1 h at room temperature with intermittent vortexing. In the same tube, 3 ml of freshly prepared Sodium methoxide (80 mg NaOH in 100 ml methanol) was added and incubated at room temperature for 30 min followed by addition of 3 ml of 0.8% aqueous sodium chloride and then shaked well. After 5 min, the upper hexane layer containing the methyl-esters were transferred to another centrifuge tube already containing 100 mg anhydrous sodium sulphate (Misra & Mathur, 1998). The hexane layer containing methyl-esters was used for Gas Chromatograph (Netel India Ltd., Model MICHRO 9100) analysis, using 15% DEGS packed column. Separation conditions in GLC involved Oven temperature at 190 °C, injector temperature at 240 °C FID detector temperature at 260 °C and. Carrier gas (nitrogen) flow rate was maintained at 30 ml min^{-1} and fuel gas (hydrogen) flow at 30 ml min^{-1}.

2.5. Extraction of free amino acids and phenolics

The defatted flour of samples (500 mg) was extracted with 10 ml of 80% ethanol and centrifuged at 5000 rpm for 10 min. Extraction was repeated four times with 10 ml portions of 80% ethanol and supernatants were pooled into 100 ml volumetric flasks and has been referred to as ethanol extract hereafter.

2.6. Estimation of total free amino acids

The total free amino acids were determined by using ninhydrin method as outlined by Misra, Mertz, and Glover (1975). To 0.4 ml ethanol extract in a test tube, 5 ml of ninhydrin reagent was added and mixed thoroughly. The tubes were then placed in a boiling water bath for 10–12 min and then brought to room temperature under running water. The absorbance of the colour was read at 570 nm. The standard curve was prepared by using glycine in the range of 0–80 μg.

2.7. Estimation of total phenolics

A modified Folin–Ciocalteu procedure as described by Jayaprakasha, Singh, and Sakariah (2001) was used for the determination of total phenolic contents. One ml ethanol extract was transferred to a test tube and then alcohol was evaporated till dryness. The residue was dissolved in 1.0 ml water. The Folin and Ciocalteu reagent, 0.5 ml (1:1 with water), was added to each test tube, mixed, and allowed to stand for 3 min. Subsequently, 2 ml, 20% Na_2CO_3, was added, mixed thoroughly and then placed in a boiling water bath for one minute and cooled in ice water and the colour was read at 650 nm. Catechol (0–25 μg) was used as the standard.