

Standardization, chemical characterization and storage studies of an instant *pulihora* mix based on raw mango

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Raw mangoes were dehydrated, powdered and mixed with other selected processed spice ingredients to obtain an instant *pulihora* mix (IPM). The instant mix was found to contain protein and fiber contents of 13.2 and 5.6%, respectively. The mix was a rich source of total polyphenols (636 mg/100 gm) and phosphorous (238 mg/100gm). The mix was found to be a good source of linoleic acid (6.62%). During storage, the free fatty acid and peroxide contents increased from 0.08 to 0.28% and 4.42 to 44.3 meq/kg of fat, respectively. Sorption isotherm revealed that IPM possessed non-hygroscopic nature though it contained 25% of the dehydrated raw mango powder. The critical moisture content of the mix was 12.95% which equilibrated at 65% relative humidity. Sensory analysis of the IPM reconstituted with cooked rice scored 'good' (7.7) even after a storage period of six months.

Keywords: Mango, *Pulihora* mix, Physico-chemical analysis, ERH studies, Fatty acid composition, Sensory evaluation

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Raw mango (*Mangifera indica* L.) is known to possess good amount of citric and malic acids along with other nutrients. India produces 65% of the world's mango crop with a crop area of 10, 00,000 ha which occupies 70% of its fruit growing area. It was reported that 13.5 million tonnes of mangoes were produced during the period 2006-2007¹. India exports two thirds of the total processed mangos (20,000 MT) and its main destinations are USA and UK. Fruits are popularly eaten as table fruits, juice, smoothie, jam, squash, bar, etc. Raw green mangoes are mainly used in the processing of pickles, chutneys and dehydrated powders (*amchur*). Dehydration of raw mangoes is carried out in Indian households or at cottage scale and in some traditional practices by mixing with salt and turmeric. The dehydrated mango powder is known as *amchur* and is categorized under spices for various reasons such as its applications in spice mixes for various snack/chat foods, and is generally used as an acidulant in place of tamarind in the northern Indian states. Raw mangoes are also used in the preparation of traditional beverages with a cooling effect known as *panna* in the hot summer months. *Chutneys* and *dhal* preparations are generally made by using raw mangoes

at household level though such preparations are not shelf-stable and are consumed as and when they are prepared in a day or two. They are highly susceptible to mold growth as they are intermediate moisture foods and cannot be stored without refrigeration.

Dehydration of raw mangoes for preparation of *amchur* powder (raw mango powder) was studied in detail by number of workers²⁻⁴. Green mango processing for various operations such as physico-chemical characteristics, thin layer drying kinetics, different processing methods, treatments, drying, re-constitution of dehydrated slices, packaging, storage studies, preparation of pickles and lactic acid fermentation were reviewed⁵. Raw mango peel was investigated for antioxidant activity⁶. These workers have studied the preparation of *amchur* powder but not its application in other foods or instant mixes.

Pickles and chutneys are popular adjuncts with rice and breakfast foods such as *idli*, *dosa*, *vada* and other snack foods. Several standard blends of *chutney* powders for use in rice or breakfast foods based on tamarind leaf, curry leaf, *pudina* and *Hibiscus* species, raw tamarind and raw mango were reported in the literature⁷⁻¹¹. *Pulihora* (*Puliyogare*) is a sour and spicy product made from rice, tamarind extract and seasoning with oil and spices. This product is a popular

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item of many South Indian households and is prepared in most of the Indian temples as *prasadam* (offering to God). The general preparation of the traditional product involves extraction of tamarind solids into water, cooking the extract along with salt, and oil; mixing with cooked rice, turmeric, roasted groundnut, curry leaf, and seasoning¹². The process is cumbersome, lengthy and time consuming. Usage of lime juice or mango gratings is a common practice in South Indian homes. To overcome the drudgery involved with the traditional practices, instant-mixes were introduced by using concentrated tamarind pulp/dehydrated tamarind powder, salt, fried spices and seasoning material.

The literature is abundant with reports on application of mango pulp in various products; however the industrial use of raw green mangoes is limited to dehydration and in the manufacture of pickles. All most all the instant *pulihora* mixes are tamarind based pastes and pastes available in the market when mixed with rice and oil yield a yellow coloured product similar in appearance to the traditional product because of addition of turmeric powder. However, the taste of these prepared products is either bland or completely different from the freshly made traditional *pulihora*. During storage, these products also tend to turn brown thereby imparting an odd colour to the end products.

In the present investigation, dehydrated raw green mango powder is used to make an instant *pulihora mix* product in powder form for use in the preparation of instant *pulihora*. The physico-chemical analysis and storage studies of the instant *pulihora* mix were carried out for a period of six months.

Methodology

Raw green mangoes (var. *neelam*) black gram (*Phasleous mungo*), chickpea (*Cicer arietinum*), red chillies (*Capsicum annuum*), cumin (*Cuminum cyminum*), black mustard (*Brassica nigra*), peanut (*Arachis hypogea*) and peanut oil were purchased from local market.

Preparation of raw mango based instant *pulihora* mix (IPM)

Raw green mangoes (4 kg) were cleaned in running water, peeled, kernel (seed) removed, sliced into small pieces of 4-5 cm length and 2 cm in thickness and subjected to treatments, viz. blanching in 3% boiling sodium chloride solution for 2 min and sulphitation by exposing to sulphur dioxide fumes by burning sulphur at the rate of 1gm per kg mango

slices for 2 hrs followed by cabinet tray drying at $50 \pm 2^\circ\text{C}$ for 8 h. The dried flakes were ground in a hammer mill to a fine powder to pass through BS 30 mesh and obtained 0.7 kg of powder. Red chillies, peanuts and black gram were roasted individually in a pan by smearing a small quantity of groundnut oil and cumin seeds were roasted without oil to remove the raw odour and also to improve the flavour.

Raw mango powder was mixed with salt, turmeric, ground red chilly powder, individually roasted chickpea, groundnut, whole red chilly, mustard, cumin seeds, de-husked black gram, curry leaf and asafoetida. The composition of the mix was standardized by conducting various trials altering the dehydrated mango powder, salt, pulse and other ingredients. The instant *pulihora* mix (IPM) obtained was an acidulant mix ready for application into rice to yield a highly attractive and acceptable *pulihora*.

ERH studies

Equilibrium relative humidity data of the IPM was collected to assess the effect of various humidity conditions on the storage behavior of product. Moisture sorption isotherm was plotted by exposing the IPM to varying conditions ranging between 10 - 100% relative humidity (RH) in glass desiccators maintained using sulphuric acid¹³ at room temperature ($28 \pm 2^\circ\text{C}$). The moisture uptake or losses in IPM samples were measured at regular intervals by weighing 5 gm of mix in petri plates exposed to the above conditions until equilibrating to constant weight or till appearance of fungal growth. Lump formation, discoloration or mold growth in the samples during the experiment was carefully monitored for determining the critical moisture content.

Packaging, physico-chemical, sensory evaluation and storage studies of IPM

The IPM product was packed in 100 gm unit packs of metallized polyester (12.5μ) polyethylene (7.5μ) (MPE) laminated pouches of 14 cm $\times$ 12 cm and was stored for six months at room temperature ($28 \pm 2^\circ\text{C}$). The proximate composition, mineral content and total polyphenols were analysed initially and selected parameters namely moisture, acidity as citric acid, total polyphenols and free fatty acids and peroxide of extracted fat from the mix were analysed during the storage period of six months. Parameters such as moisture, total ash, crude fat, crude protein, crude fiber, starch and acidity as citric acid were analysed by standard methods¹⁴. Carbohydrate content was

calculated by difference. Salt content in *chutney* powder was estimated as per AOAC method (1965)¹⁵. Calcium (Ca), iron (Fe) phosphorous contents were estimated by standard methods¹⁶. Total polyphenol content was determined by the method suggested by Sadasivam and Manickam (1997)¹⁷. Free fatty acid (FFA) and peroxide (POV) of samples were carried out according to the reported methods suggested by Ranganna (1986)¹⁴.

The storage stability of the IPM was carried out by subjecting IPM to sensory evaluation at bi-monthly intervals. Sensory attributes like colour, appearance, taste and overall acceptability of IPM was evaluated by a trained panel of 10 judges on 9 point Hedonic scale¹⁸. The evaluation was conducted for the mix after it was mixed with cooked rice in the ratio of 1: 6.9, considering the traditional *pulihora* product as control.

Fatty acid composition by GC and GC-MS

The fat was extracted from the IPM and converted to their fatty acid methyl esters (FAME) by refluxing with methanol containing 2% sulphuric acid. The FAMES were analysed by Gas chromatography and Gas chromatography - Mass spectrometry as per the method reported by Prabhakara Rao *et al.* (2009)¹⁹. The GC-FID analyses were performed with an Agilent 6850 series gas chromatograph equipped with an FID detector. The chromatographic conditions for GC-FID were adjusted according to the class of compound. For fatty acid methyl esters (FAME), a DB-225 capillary column (30 m × 0.25 mm i.d) was used. The column temperature was initially maintained at 160°C for 2 min, increased to 220°C at 6°C/min, and finally maintained for 10 min at 220°C. The carrier gas was nitrogen at a flow rate of 1.5 mL/min. The injector and detector temperatures were maintained at 230 and 250°C, respectively with a split ratio of 50:1.

The GC-MS analyses was performed using an Agilent (Palo Alto, USA) 6890N gas chromatograph equipped with a HP-5 MS capillary column (30 m × 0.25 mm i.d.) connected to an Agilent 5973 mass spectrometer operating in the EI mode (70 eV; *m/z* 50– 550; source temperature 230°C and a quadruple temperature 150°C). The column temperature was initially maintained at 200°C for 2 min, increased to 300°C at 4°C/min, and maintained for 20 min at 300°C. The carrier gas was helium at a flow rate of 1.0 mL/min. The inlet temperature was maintained at 300°C with a split ratio of 50:1. Structural assignments were based on interpretation of mass spectrometric fragmentation and

confirmed by comparison of retention times as well as fragmentation pattern of authentic compounds and the spectral data obtained from the Wiley and NIST libraries.

Results and discussion

Standardization of IPM

The unit operations involved in the preparation of the standardized instant *pulihora* mix is presented in Fig. 1. Raw green mangoes yield 17.5% of dehydrated

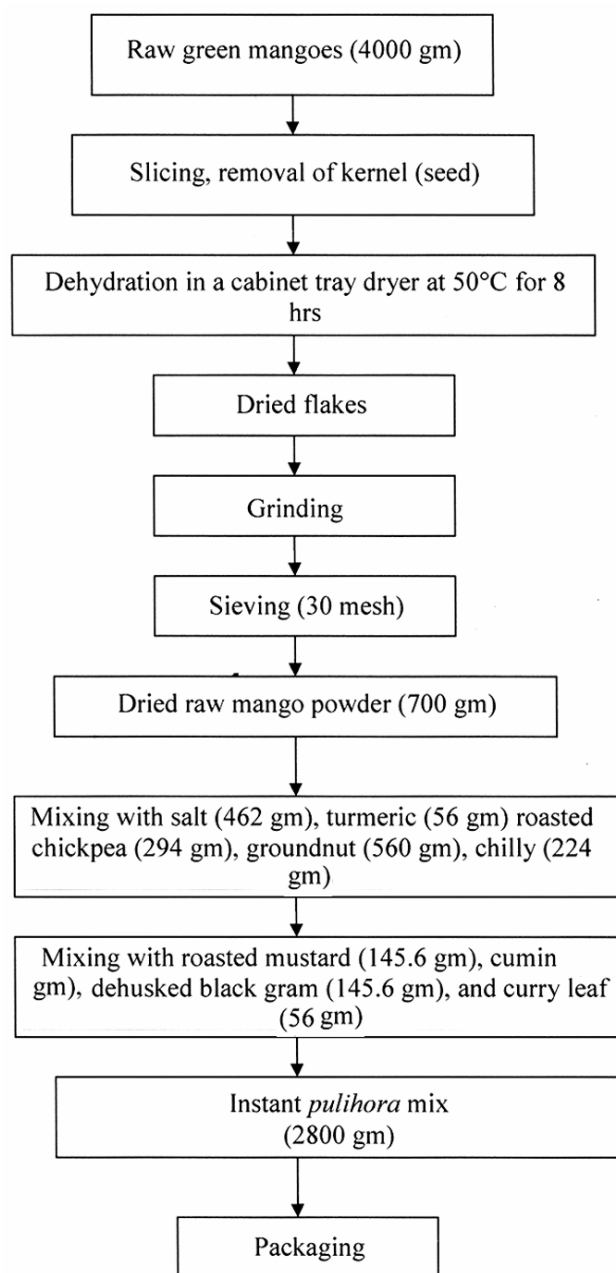


Fig. 1—Flow chart for the preparation of instant *pulihora* mix

mango powder which can be blended with selected spice, salt and pulse ingredients to make 2800 g of IPM. The composition of the standardized IPM is presented in Table 1. The mix contains 30% of dehydrated mango powder, 10% roasted pea nuts, 17.5 % salt and 12.5 % roasted chick pea as the main ingredients.

Sorption isotherm for the IPM

The sorption isotherm of IPM is presented in Fig. 2. The initial moisture content of the mix was 5.37 which equilibrated at 48% relative humidity. It was observed that the critical moisture content of 12.95% which equilibrated to 65% RH. The sudden rise in moisture content was observed at > 70% RH and hence it can be deduced that the packaging material required for IPM should possess good gas and moisture barrier properties and the selection of metallised polyester polyethylene laminate would be a right choice.

Proximate composition, mineral content and polyphenol composition of the IPM

The proximate composition, mineral content and total polyphenols are presented in Table 2. It was observed that the mix was rich in protein (13%), fat (18%) and crude fibre (5.6%). Minerals such as Ca, Fe and P were found to be 30, 1.5, 238 mg/100gm, respectively. Total polyphenols were observed to be 636 mg/100gm. Research on polyphenols on the health benefits strongly recommended polyphenols in the prevention of degenerative diseases such as cardiovascular diseases and cancers and it was suggested that the mechanisms of action of polyphenols go beyond the antioxidative action²⁰.

Fatty acid composition of the extracted fat from the IPM

The fatty acid composition of the IPM mix extracted fat based on gas chromatography and mass spectrometry. The fatty acid composition is presented on IPM basis (Table 3). It was found that the *pulihora* mix was rich source of both oleic (18:1) and linoleic acid (18:2) at 6.62%. The other major fatty acids were palmitic acid (2.03%) and erucic acid (0.94%). Cho *et al.* (2002)²¹ reported that the binding of low-density lipoprotein (LDL) with 18:0, 18:1, 18:2 and 18:3 was suggested to be the major action in lowering LDL-cholesterol levels. Substitution of dietary saturated fat by oleic acid and/or polyunsaturated fatty acids (PUFA) has been described to reduce the cardiovascular risk by reducing blood lipids, mainly cholesterol²².

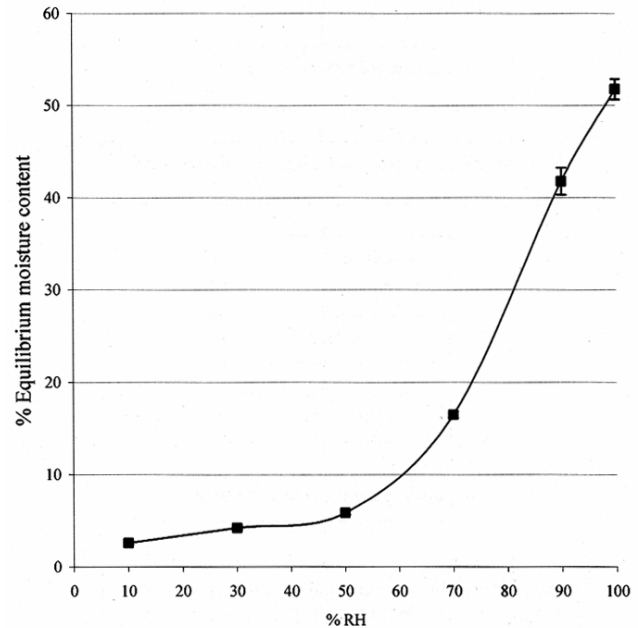


Fig. 2—Sorption isotherm of instant *pulihora* mix

Table 1—Composition of the standardized instant *pulihora* mix

Ingredients	Composition (gm/100gm IPM)
Raw mango powder	30.0
Salt	17.5
Turmeric	2.0
Red chilly powder	3.5
Roasted chick pea	12.5
Groundnut	10.0
Red chilly	9.0
Mustard	5.2
Cumin	2.0
Dehusked black gram	5.2
Curry leaf	3.0
Asafoetida	0.1

Table 2—Chemical composition, mineral and polyphenol content of ipm*

Parameters	Instant acidulant raw mango mix
Moisture, %	5.37 ± 0.23
Total ash, %	20.26 ± 0.15
Acid insoluble ash	0.077 ± 0.02
Crude protein, % N x 6.25	13.27 ± 0.53
Crude fat, %	18.21 ± 0.58
Crude fibre, %	5.67 ± 0.39
Carbohydrates by difference	45.24 ± 0.58
Energy kCal/100gm	398 ± 5.39
NaCl, %	17.89 ± 0.70
Acidity as citric acid, %	4.28 ± 0.29
Calcium, mg/100 gm	30 ± 1.35
Iron mg/100 gm	1.5 ± 0.14
Phosphorous mg/100gm	238 ± 2.64
Total polyphenols	636 ± 2.00

*Instant *pulihora* mix, mean values ± SD are presented, n = 3

Effect of storage on organoleptic quality and selected chemical parameters

The scores of organoleptic evaluation of the IPM conducted with cooked rice during the storage period of 6 months were presented in Table 4. The

Table 3—Fatty acid composition of IPM*

Fatty acid	% composition
Palmitic acid (16:0)	2.03
Stearic acid (18:0)	0.71
Eicosanoic acid (20:0)	0.27
Docasanoic acid (22:0)	0.27
Tetracosanoic acid (24:0)	0.16
Saturated	3.44
Oleic acid (18:1)	6.62
Eicosaenoic acid (20:1)	0.27
Erucic acid (22:1)	0.94
Tetracosenoic acid (24:1)	0.03
Mono Unsaturated	7.86
Linolenic acid (18:2)	6.62
Linolenic acid (18:3)	0.29
Polyunsaturated	6.91

*Instant *pulihora* mix, percentage composition is computed on IPM basis

Table 4—Sensory quality of instant *pulihora* mix (ipm) during storage*

Parameter	Storage period (Months)			
	0 (fresh)	2	4	6
Appearance	8.7 ± 0.16	8.4 ± 0.29	8.2 ± 0.24	8.1 ± 0.35
Colour	8.3 ± 0.26	8.1 ± 0.23	7.9 ± 0.15	7.4 ± 0.23
Flavour	7.9 ± 0.20	7.6 ± 0.19	7.4 ± 0.23	6.9 ± 0.12
Taste	8.6 ± 0.34	8.4 ± 0.31	8.1 ± 0.14	7.8 ± 0.38
Overall quality	8.2 ± 0.21	8.2 ± 0.35	7.9 ± 0.20	7.7 ± 0.31

*Mean values ± SD are presented, n = 10 panelists

overall acceptability of the mix was 8.2 initially and it was 7.7 after a storage period of six months. Appearance and colour of the product received high scores of 8.1 and 7.4, respectively, though flavour was 6.9 at the end of the storage period of six months.

The effect of storage on selected parameters for assessing the storage stability is presented in Table 5. It was noticed that negligible variation was observed in moisture content during storage period of six months. However, the acidity changed minimally and a increase in polyphenol content was observed. A similar increase in polyphenols during storage was observed in dehydrated green chilly²³. Free fatty acid content of the extracted fat increased marginally from 0.08% to 0.28% and the increase in peroxide value was from 4.42 to 44.3 meq of O₂/kg fat during six months of storage. Though FFA and POV values increased, it did not affect the sensory scores during storage and panelists could not identify any off flavour. An earlier study of tamarind leaf chutney powder⁹ showed a similar trend during storage.

Conclusion

Instant *pulihora* mix based on raw mango was acceptable for six months. The instant *pulihora* mix was not only rich in protein, fibre and polyphenols and also a convenient instant mix in the form of powder for the preparation of *pulihora*. The product packed in aluminum foil laminate pouches stored well at room temperature for a period of six months. The mix was a good source of unsaturated fatty acids, oleic and linoleic acids. The raw mango based *pulihora* mix is a convenient ready mix, a non-hygroscopic product, which yields a highly attractive and acceptable *pulihora* with 0.54% acidity as citric acid and 2.2% salt.

Table 5—Changes in composition of instant *pulihora* mix during storage*

Parameters	Storage period (Months)			
	0 (fresh)	2	4	6
Moisture content, %	5.37 ± 0.23	5.32 ± 0.20	5.30 ± 0.06	5.30 ± 0.16
Acidity as % citric acid	4.22 ± 0.29	4.28 ± 0.23	4.49 ± 0.19	4.77 ± 0.18
Total polyphenol content mg/100gm	636 ± 2.00	670 ± 4.50	705 ± 5.00	755 ± 6.20
Quality of extracted fat				
FFA (% as oleic acid)	0.08 ± 0.01	0.10 ± 0.02	0.19 ± 0.01	0.28 ± 0.03
Peroxide value (PV) meq of O ₂ per kg fat	4.42 ± 0.12	9.58 ± 0.16	26.5 ± 0.37	44.3 ± 0.30

*Mean values ± SD are presented, n = 3

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References

- Anonymous, Food and Agricultural Organization of United Nations: Economic and Social Department: The Statistical Division, 2007.
- Dabhade R S & Khedkar D M, Dehydration of raw mangoes for preparation of *amchur* powder, *Indian Food Packer*, 34 (3) (1980) 43-47.
- Goyal R K, Kingsly A R P, Manikantan M R & Ilyas S M, Thin-layer drying kinetics of raw mango slices, *Biosystems Engg*, 95(1) (2006) 43-49.
- Mehta G L & Tomar M C, Dehydration and utilization of raw mangoes, *Indian Food Packer*, 36 (6) (1982) 75.
- Teotia M S, Mannan J K & Saxena A K, Review on green mango processing, *Indian Food Packer*, 41(6) (1987) 75-86.
- Ajila C M, Bhat S G & Prasada Rao U J S, Valuable components of raw and ripe peels from two Indian mango varieties, *Food Chem*, 102(4) (2007) 1006-1011.
- Satyanarayana A, Giridhar N, Balaswamy K, Shivaswamy & Rao D G, Studies on development of instant chutneys from Pudina (Mint, *Mentha spicata*) and Gongura (*Hibiscus* sp), *J Food Sci Technol*, 38(5) (2001) 512-514.
- Balaswamy K, Jyothirmayi T & Rao D G, Studies on preparation of curry leaf (*Murraya koenigii* L.) chutney powder, *Foodservice Res Int*, 14 (2004) 175-187.
- Prabhakara Rao P G, Narsing Rao G, Satyanarayana A & Rao D G, Studies on chutney powders based on tamarind (*Tamarindus indica* L.) leaves, *Foodservice Research Int*, 15 (1) (2005) 13-24.
- Jyothirmayi T, Narsing Rao G & Rao D G, Studies on instant raw tamarind chutney powder, *J Foodservice*, 17 (2006) 119-123.
- Narsing Rao G, Prabhakara Rao P G, Jyothirmayi T & Rao D G, Chemical composition, standardisation and storage studies on raw mango chutney powder, *J Food Sci Technol*, 45(5) (2008) 436-438.
- Pushpamma P & Geervani P, *Nutritive value of traditional recipes of Andhra Pradesh*, (Andhra Pradesh Agriculture University, Hyderabad, India), 1981.
- Landrock A A & Procter B E, A new graphical interpretation method for obtaining humidity equilibria data, with special reference to its role in food packaging studies, *Food Technol*, 5 (1951) 332-337.
- Ranganna S, *Hand book of analysis and quality control for fruit and vegetable products*, IInd edn, (Tata McGraw-Hill Publishers, New Delhi), 1986.
- Anonymous, *Official Methods of Analysis*, 16th edn, (Association of Official Analytical Chemists, Washington, DC), 1995.
- Anonymous, *Official Methods of Analysis*, 10th edn, (Association of Official Analytical Chemists, Washington, DC), 1965.
- Sadasivam S, & Manickam A, In: *Biochemical Methods*, 2nd edn, (New Age International Publishers, New Delhi, India), 1997, 193-194.
- Amerine M A, Pangborn R M & Roessler E B, In: *Principles of sensory evaluation of food*, (Academic Press, New York), 1965.
- Prabhakara Rao P G, Narsing Rao G, Jyothirmayi T, Karuna M S L & Prasad R B N, Analysis of lipid classes and fatty acid composition of Jangle jalebi (*Pithecellobium dulce* L.) seed oil, *J Lipid Sci Technol*, 41(1) (2009) 5-7.
- Scalbert A, Johnson I T & Saltmarsh M, Polyphenols: antioxidants and beyond, Presented at the 1st International Conference on Polyphenols and Health, held in Vichy, France, November 18-21, 2004.
- Cho B H S, Dokko R C & Chung B H, Oleic, linoleic and linolenic acids enhance receptor-mediated uptake of low density lipoproteins in Hep-G2 cells, *J Nutr Biochem*, 13(6) (2002) 330-336.
- Lopez-Huertas E, Health effects of oleic acid and long chain omega-3 fatty acids EPA and DHA enriched milks. A review of intervention studies, *Pharmacol Res*, 61(3) (2010) 200-207.
- Jyothirmayi T, Narsing Rao G & Rao D G, Physicochemical changes during processing and storage of green chili (*Capsicum annuum*) powders, *J Food Process Preserv*, 32(5) (2008) 868 - 880.