Total salinity stress on physico-chemical characterization of lecithin isolated from soya bean oil seeds grown in the coastal region of south, India

Pragasam Antony a,b, Preeti N. Tallur a, Sikandar I. Mulla c, Vinayak M. Naik a,b*

aDepartment of Chemistry, Govt. Arts and Science College, Karwar-581301, Karnataka State, India. bResearch & Development Centre, Bharathiar University, Coimbatore-641046, Tamil nadu State, India. cDepartment of Biochemistry, Karnatak University, Dharwad 580 003, Karnataka State, India.

ABSTRACT

Phospholipid is very essential in the balanced diet. The vegetarian people in the coastal area are habitant of using edible oil seeds as daily food grains. Salinity of water during cultivation decreases the accumulation of oil content (12-15%) in seeds. Present experiment was focused on total salinity and ionic stress on physiochemical characterization of extracted lecithin from soya bean oil under saline and non-saline cultivations. The experiment proves that the percentage of phospholipids in oil and lecithin is decreased by 1.02% and 8.08%, respectively under saline cultivation. The phospholipids of the lecithin were qualitatively identified by thin-layer chromatography (TLC) and high performance of liquid chromatography (HPLC). The Rf values for phosphatidyl-ethanolamine (PE), phosphatidyl-serine (PS), phosphatidyl-inositol (PI) and phosphatidyl-choline (PC) of samples were well related to the standard. HPLC spectrum is well resolved and the retention time (RT) is correlated the standard with high precision. Quantisation of phospholipids shows a variation in the average percentage of PC, PI, PS and PE as 17.925, 9.125, 8.525, 18.975 for non-saline cultivation and 22.25, 12.025, 8.525, 15% for saline cultivation. Average decrease in the percentage in saline cultivation is due to the total salinity and ionic (Na+Cl-) stress of water.

INTRODUCTION

Vegetable materials usually contain only small amounts of phospholipids, ranging from 0.3 to 2.5 wt. % (Wagner and Wolff, 1964). Phospholipids are complex lipids which contains one or more phosphate groups. Phospholipids are amphipathic in nature that is each molecule consists of a hydrophilic portion and a hydrophobic portion thus tending to form lipid bilayers (Dowhan and Bogdanov, 2002). In fact, they are the major structural constituents of all biological membranes, although they may be also involved in other functions such as signal transduction. The most abundant types of naturally occurring glycerol phospholipids are phosphatidyl-choline, phosphatidyl-ethanolamine, phosphatidyl-serine, phosphatidyl-inositol, phosphatidyl-glycerol and cardiolipin. The structural diversity within each type of phosphoglyceride is due to the variability of the head group, variability of the chain length and degree of saturation of the fatty acid ester groups. Phosphatidyl-choline Provides free choline in the blood for the manufacture of acetylcholine which regulates digestive, cardiovascular and liver functions (Alvarez et al., 1997; Spiers et al., 1996). Phosphatidyl-choline and Phosphatidyl-ethanolamine (80:20) is essentialfor the production of stable liposomes, anti-sputtering agent in margarine. Phosphatidyl-serine is essential to the functioning of all body cell, supports brain functions that decline with age, memory enhancer (Kidd, 1996). In case of pure vegetarians, it is so essential to make up the phospholipid content having vegetables and edible oil grains in their balanced diet. The plant sources of phospholipids are soybean (Wagner and Wolff, 1964), rapeseed (Sosulki, 1981), sunflower (Litinova et al., 1971), cottonseed and peanut (Vijayalaxmi et al., 1969), ricebren (Adhikari and Adhikari, 1986), palm, coriander, carrot (Goh et al., 1982), papaya (Prasad et al., 1987), olive, barley, cucurbit (Schneider, 1989), corn, karanja,
castor bean (Paulose et al., 1966), cocoa (Parsons et al., 1969), neem (Prasad et al., 1981), sesame, khakan (Prasad et al., 1979), pear, quince, tobacco (Zlatanov et al., 2000). Phospholipids are removed as by-product during the degumming process of vegetable oil refining.

Soybean seed is a major source of high-quality protein and oil for human consumption (Katerji et al., 2001). The unique chemical composition of soybean has made it one of the most valuable agronomic crops worldwide (Thomas et al., 2003). Its protein has great potential as a major source of dietary protein. The oil produced from soybean is highly digestible and contains no cholesterol (Essa and Al-ani, 2001). Growth, development and yield of soybean are the result of genetic potential interacting with environment. Protein and oil content is related with environmental factors like moisture, temperature etc.

The 2002 U.S. soybean crop had an average protein (35.5%) and oil (19.3%) content because of hot and dry weather conditions in those areas contributed to poor yields (Brumm and Hurburgh Jr, 2002). Soybean seed production may be limited by environmental stresses such as soil salinity (Ghassemi-Golezani et al., 2009). Minimizing environmental stress will optimize seed yield (McWilliams et al. 2004). Soil salinity, resulting from natural processes or from crop irrigation with saline water, occurs in many arid and semi-arid regions of the world (Meloni et al., 2004). Salinity is a worldwide problem, affecting about 95 million hectares worldwide (Kazemghassemi-Golezani et al., 2010). The UNEP (United Nations Environment Program) estimates that 20% of the agricultural land and 50% of the cropland in the world is salt-stressed (Yan, 2008).

Most of the salt stresses in nature are due to Na+ salts, particularly NaCl (Demirel, 2005). High salinity lowers water potential and induces ionic stress, and results in secondary oxidative stress. It severely limits growth and development of plants by affecting different metabolic processes such as CO2 assimilation, oil and protein synthesis (Nasir khan et al., 2007). Present work is mainly focused on the variation of phospholipids content due to salt tress of salinity of water during cultivation of soybeans.

MATERIALS AND METHODS

Chemicals

2-Propanol, n-hexane, acetic acid and chloroform with highest purity (HPLC grade) were procured from Hi-Media. Methanol, acetic acid, sodium acetate, per chloric acid, ammonium molybdate, aminonaphtholsulphonic acid, potassium dihydrogen phosphate, petroleum ether and acetone with highest purity (AR grade) were procured from S.D. Fine and Merck.

Collection of samples

Four varieties of soy bean seeds were collected from coastal and non-coastal region of Karnataka, Tamil Nadu and Andhra Pradesh (India) available in the weekend market. The seeds were dried under sun light first and then kept at 90°C (about three hours) in an oven. Then these are fine powdered and used for the extraction of oil. The samples were labelled as soya bean-a, soya bean-b, soya bean-c and soya bean-d for saline (coastal) cultivation and soya bean-a, soya bean-b, soya bean-c, soya bean-d, for non-saline (non-coastal) cultivation.

Extraction of oil

50±0.5 g of seed powder is packed and stapled in a Whatman grade no. 42 filtered paper. The packet is inserted into the middle piece of soxhlet extractor. Oil was extracted using petroleum ether for three hours. Petroleum ether was recovered and the oil was dried 85°C in a preheated oven for one hour. Oil obtained is cooled in a desiccator and weighed for constant weight.

Extraction of Lecithin

5 ± 0.2 g of fresh oil was dissolved in analytical grade acetone and stirred well. The insoluble lecithin was filtered and flushed with N2 gas. A feathery material was obtained which on drying in oven at 75-80°C forms a reddish brown transparent solid. It was weighed for constant weight.

High Performance Liquid Chromatogram (HPLC) analysis of phospholipids

High Performance Liquid Chromatogram (HPLC) was recorded using Shimadzu LC-2010HT instrument series of wavelength range 190-600nm with bandwidth 8nm. Instrumental wavelength accuracy and wavelength reproducibility are ±1nm and ±0.1nm. Lichrosorb, Si-60, 10µm (C18) column was saturated by 2-propanol and maintained at 30°C. 10μl of the sample in mobile phase was programmed for injection and the mobile phase n-Hexane: 2-propanol: acetate buffer (8:8:1, v/v) was pumped at rate of 2ml/min and chromatograms were recorded at 206 nm.

Quantization of lecithin

Sample was prepared by dissolving 0.1±0.005gm of extracted lecithin in chloroform according official methods and recommended practices of the American Oil Chemists Society (ACOS, 4thEdn 1990). Sample was prepared by dissolving 0.1±0.005gm of extracted lecithin in chloroform. Aliquot equivalent to 0.01±0.005gm was pipette into 30ml graduated test tubes and digested by adding 0.9ml 70 % per chloric acid at 80-90°C followed by 120°C and 150-180°C on sand bath. The colourless and clear solution in the test tube is cooled and made up to 2ml. To this 7.0ml of distilled water, 1.5ml of 2.5% ammonium molybdate and 0.2ml aminonaphtholsulphonic acid were added. The test tubes were placed in boiling water bath for exactly 7mins and cooled for 20mins. Then optical density was measured at 830nm using UV- Spectrophotometer against the blank.

Calibration curve was plotted using AR potassium dihydrogen phosphate solutions having 1to5µg of phosphorus.

\[
\text{% of phospholipids} = \frac{A \times 30.97 \times 100}{W \times 1000 \times 1000}
\]
Where, \( A \) = Phosphorus content in µg from calibration curve
\( W \) = Weight of sample in g from the sample aliquot
30.97 = Converting factor for phosphorus into phospholipids

**TLC analysis of phospholipids**

TLC plates of size 20x20 cm 0.2mm silica gel coated glass plates were activated at 110°C for 1 hour. The developing solvent was Chloroform:methanol: Acetic acid: Water (25:15:4:2, v/v). Spots were identified by Iodine vapour and eluted by Chloroform.

An aliquot of 10µg of isolated lecithin dissolved in chloroform was spotted on TLC plates. Chromatogram was developed using the mobile phase Chloroform: Methanol: Acetic acid: Water (25:15:4:2, v/v). The condition was followed exactly as given by Skipski and others. The plates were dried at room temperature for 20 min after an average time of running for 1½ hours. Spots were identified by iodine vapour and encircled using sharp needle. When iodine vapour was completely evaporated, the silica gel was scrapped using razor, quantitatively transferred into centrifuging tubes and added 2ml chloroform. It was mixed well, centrifuged and the centrifugates were collected in labelled 30ml graduated test tubes. Extractions were repeated twice for each spots and collected together in test tubes. Finally the chloroform was evaporated and residues obtained were used for the determination of different phospholipids

**RESULTS AND DISCUSSION**

**Determination oil content**

Oil was extracted from four different variety soya bean seed powdered materials by soxhlet extraction method. Seed powdered material contains 0.9-1.5% moisture. Average percentage of oil recovery from soya bean seeds grown in coastal and non-coastal cultivation by soxhlet extraction method is reproducible and regressive. Oil content per seed decreases in the coastal cultivation due to salinity stress.

| Variety of soya bean | CoAstal Cultivation | Nonsaline Cultivation |
|----------------------|---------------------|-----------------------|
|                      | Average weight (g)  | Average Oil Content (%) |  
| Soya bean-a          | 50.40               | 18.03                 |  
| Soya bean-b          | 50.10               | 18.07                 |  
| Soya bean-c          | 50.10               | 17.91                 |  
| Soya bean-d          | 50.00               | 18.15                 |  
|                      |                     |                       |  
| Non Coastal Cultivation |                     |                       |  
| Soya bean-a         | 50.22               | 20.02                 |  
| Soya bean-b         | 50.14               | 19.87                 |  
| Soya bean-c         | 50.08               | 20.18                 |  
| Soya bean-d         | 50.15               | 20.27                 |  

The Table1 correlates oil accumulation in soya bean seeds where coastal cultivation gives 18.04 per cent and that of non-coastal cultivation is 20.13%oil which relates literature value 2 1.38±0.6 % reported by American Soybean Association (Brumm and Hurburgh Jr. 2002). The recovery of oil shows linearity with regression R² equal 0.0667 for coastal and 0.5996 for non-coastal cultivation (Fig. 1).

Seeds from non-coastal cultivation have oil accumulation of 2.09% more than the seeds from coastal cultivation. This deterioration in oil content is caused by salt out effect of NaCl on soya proteins. Present work was focused on saline and non-saline condition of water for the cultivation of soya bean. Sea shore famers are dependents of saline water and faces saline stress.

**Analysis oil and Lecithin for phospholipid content**

Phospholipid content in oil and lecithin was determined by estimating the amount of phosphorus by per chloric acid digestion method using Official methods and recommended practices of the American Oil Chemists Society.

Amount of phosphorus in oil and Lecithin was estimated against sample aliquot weight. Table 2 lists the reproduce able results of the phospholipid content of soya bean oil and lecithin under saline, non-saline cultivation. The phospholipid content of oil and lecithin for soya beans in saline cultivation is relatively lesser compare to soya bean seed oil grown in non-saline cultivation.

Amount of phosphorus was determined by recording optical density using standard calibration curves (Fig. 2) thereby determining the percentage of phospholipid content of in and lecithin. Phospholipid content for oil and lecithin in saline (coastal) cultivation is 2.91% and 59.64% as compare to Non-saline (non-coastal) cultivation having 3.93% and 67.72%. These results reveal that the salinity of water is the main cause for deterioration of oil content of soya bean seeds. Saline stress on growing soya bean results in decrease of oil content and phospholipid content per seed.

![Fig. 1: Percentage of oil content soya bean for coastal and non-coastal cultivations.](image)

\[
y = 0.106x + 19.82 \\
R^2 = 0.5996
\]

\[
y = 0.02x + 17.99 \\
R^2 = 0.0667
\]
**Table 2:** Amount of phosphorus, Average percentage of phospholipid in soya bean oil and lecithin under saline, non-saline conditions.

| Variety of soyabean | Coastal cultivation | Non-Coastal cultivation |
|---------------------|---------------------|------------------------|
|                      | Acetone Insoluble Matter (AIM) |                      |
| Wt. in aliquot (g) 1x10^{-4} | Optical Density | Phosphorus content in µg | Average % of phospholipid | Wt. in aliquot (g) 1x10^{-4} | Optical Density | Phosphorus content in µg | Average % of phospholipid |
| Soya-bean-a         | 5.31                 | 0.053                  | 0.51                      | 2.97                     | 1.01                  | 0.202                  | 1.94                       | 59.49                      |
| Soya-bean-b         | 5.60                 | 0.054                  | 0.52                      | 2.84                     | 0.99                  | 0.200                  | 1.92                       | 60.10                      |
| Soya-bean-c         | 5.26                 | 0.052                  | 0.50                      | 2.94                     | 1.03                  | 0.205                  | 1.97                       | 59.25                      |
| Soya-bean-d         | 5.69                 | 0.055                  | 0.53                      | 2.88                     | 0.98                  | 0.197                  | 1.89                       | 59.73                      |
| Soya-bean-a         | 4.48                 | 0.051                  | 0.49                      | 3.39                     | 0.89                  | 0.203                  | 1.95                       | 67.90                      |
| Soya-bean-b         | 4.58                 | 0.053                  | 0.51                      | 3.45                     | 0.95                  | 0.213                  | 2.05                       | 66.98                      |
| Soya-bean-c         | 4.30                 | 0.050                  | 0.48                      | 3.46                     | 0.94                  | 0.215                  | 2.07                       | 68.03                      |
| Soya-bean-d         | 4.60                 | 0.054                  | 0.52                      | 3.50                     | 0.90                  | 0.206                  | 1.98                       | 67.96                      |

**Fig. 2:** Calibration curve for phosphorus content, in saline cultivation (a) and non-saline cultivation (b).

**Qualitative identification of phospholipids Lecithin**

*Thin Layer Chromatography (TLC)*

Fig. 3 gives one dimensional TLC of isolated lecithin (AIM) and the standard commercial lecithin of purity 35% against PC. The spots were identified as PE, PS, PI, and PC in comparison with the standard on exposing to iodine vapour in iodine chamber.

R<sub>f</sub> values of each spot was determined as ratio of the distance travelled by solvent (solvent front) to the distance travelled by the spots and related with the standard.

**Table 3:** R<sub>f</sub> values of Phospholipids of standard and samples.

| Phospholipids | S | 1 | 2 | 3 | 4 |
|---------------|---|---|---|---|---|
| PE            | 0.912 | 0.918 | 0.912 | 0.906 | 0.918 |
| PS            | 0.835 | 0.829 | 0.829 | 0.835 | 0.841 |
| PI            | 0.794 | 0.788 | 0.788 | 0.794 | 0.782 |
| PC            | 0.670 | 0.676 | 0.670 | 0.665 | 0.672 |

**High Performance Liquid Chromatography (HPLC)**

The identification of different phospholipids was further confirmed by HPLC. Fig. 4 gives relatively comparable chromatograms. Retention time of each phospholipid was well related and resolved. Table 4 lists retention time for each phospholipid and correlates the chromatograms of the standard and the samples.
Table 4: HPLC Retention time for PE, PA, PI and PC of soya lecithin.

| Phospholipid | Retention Time (Standard) Min | Retention Time (Coastal cultivation) Min | Retention Time (Non-Coastal cultivation) Min |
|--------------|-------------------------------|------------------------------------------|---------------------------------------------|
| PE           | 4.64                          | 4.65                                     | 4.63                                        |
| PA           | 2.71                          | 2.73                                     | 2.73                                        |
| PI           | 3.59                          | 3.61                                     | 3.62                                        |
| PC           | 8.03                          | 8.07                                     | 8.07                                        |

Fig. 4: HPLC of Soya Lecithin (a) Standard and (b) Samples from saline and non-saline cultivation.

Quantization of Phospholipids in Lecithin

An aliquot containing 10µg of each sample of lecithin in chloroform was spotted quantitatively on TLC plate and the spots were identified by iodine vapour (Fig. 5). Corresponding spots were marked using a sharp needle and silica gel was removed using razor after the complete elimination of iodine vapour adhere to the silica gel.

The phospholipids were quantitatively estimated by the experimental procedure. Table 5 summarises the relative percentage of PC, PI, PS and PE in the lecithin isolated from different variety of soya bean seeds obtained from saline and non-saline cultivations. Quantitative determination of Phospholipids by TLC gives an average percentage of PC, PI, PS and PE as 17.925, 9.125, 5.9, 15.1 for saline cultivation and 22.25, 12.025, 8.525, 18.975 for non-saline cultivation. The relative percentage of phospholipids in non-saline cultivation is higher than the saline cultivation.

The main cause for the decrease in the phospholipids content is the salinity and ionic (NaCl) stress due to sodium chloride on accumulation of oil and phospholipids content. High concentration of total salt in water decreases the nitrogen fixation

Table 5: TLC quantisation of phospholipids of soya bean lecithin for saline and non-saline cultivation.

| Soya bean     | Wt. of PL in aliquot 1x10^4 | Coastal Cultivation | Non-Coastal cultivation |
|---------------|------------------------------|---------------------|-------------------------|
|               |                              | PC                  | PI                      | PS                      | PE                      | PC                  | PI                  | PS                  | PE                  |
| Soya bean-a   | 1.20                         | 0.72                | 0.36                   | 0.23                   | 0.60                   | 18.2                | 9.3                 | 5.9                 | 15.5                |
| Soya bean-b   | 1.10                         | 0.63                | 0.32                   | 0.22                   | 0.53                   | 17.8                | 8.9                 | 6.1                 | 14.8                |
| Soya bean-c   | 1.05                         | 0.60                | 0.31                   | 0.19                   | 0.51                   | 17.6                | 9.1                 | 5.7                 | 15.1                |
| Soya bean-d   | 1.07                         | 0.63                | 0.32                   | 0.20                   | 0.52                   | 18.1                | 9.2                 | 5.9                 | 15.0                |
| Soya bean-a   | 1.04                         | 0.75                | 0.41                   | 0.29                   | 0.63                   | 22.2                | 12.1                | 8.5                 | 18.8                |
| Soya bean-b   | 1.12                         | 0.82                | 0.43                   | 0.30                   | 0.70                   | 22.6                | 11.9                | 8.3                 | 19.3                |
| Soya bean-c   | 1.14                         | 0.81                | 0.45                   | 0.31                   | 0.69                   | 21.9                | 12.2                | 8.4                 | 18.7                |
| Soya bean-d   | 1.20                         | 0.86                | 0.46                   | 0.35                   | 0.74                   | 22.3                | 11.9                | 8.9                 | 19.1                |

Fig. 5: (a) TLC spots for phospholipids after exposing to iodine vapour and (b) TLC spots for phospholipids after the removal of silica gel.
and salting out the protein accumulation. The overall results
evidences the salinity stress adversely affects the accumulation of
phospholipid percentage in the soya bean oil seeds.

CONCLUSION

Present work was focused on salinity stress for the
cultivation of soya bean under saline and non-saline conditions.
Four varieties of soya bean seeds from coastal and non-coastal
cultivation were analysed for oil and phospholipid content. The
experimental result proves that the non-saline (Non-coastal)
cultivation have higher oil and total phospholipid content (20.09%
and 67.72%) than the saline (coastal) cultivation (18.04% and
59.64%). The experiment was also conducted for qualitative
identification of individual phospholipids (PC, PI, PS and PE) by
one dimensional TLC and HPLC spectrum. The spectral results
were well related with the standard and the quantisation of
phospholipids by TLC gives that the individual phospholipid
content for non-saline cultivation is higher than that of saline
cultivation. In summary, the overall results contribute to novelist
of the experiments that the total ionic and salinity stress causes a
decrease in total and individual phospholipid contents of soya bean
seeds.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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REFERENCES

Adhikari S, Adhikari J. Indian rice bran lecithin. Journal of the
American Oil Chemists Society, 1986; 63:1367-1369.
Alvarez XA, Laredo M, Corzo D, Fernandez-Novoa L, Mouzo
R, Perea JE, Daniele D, Cababeros R. Citoline improves memory
performance in elderly subjects. Methods and findings in experimental and
clinical pharmacology, 1997; 19:201-210.
Brumm TJ, Hurburgh Jr, CR. 2002. Quality of the Soybean
Crop from the United States. Report to the American Soybean
Association.
Dowhan W, Bogdanov M. 2002. Functional Roles of lipids in
membranes, in: D. Vance, J.E. Vance (Eds.) Biochemistry of lipids,
Lipoproteins and Membranes Elsevier Science.
EssaTA, Al-Ani DH. Effect of salt stress on the performance of
six soya bean genotypes. Pakistan Journal of Biological Sciences.2001;
4:175-177.
Ghasemi-Golezani K, Taifeh-Noori M., Oustan S, Moghaddam
M, Seyyed-Rahmani S. Oil and protein accumulation in soybean grains
under salinity stress. Notulae Scientia Biologicae. 2010; 2:64-67.
Goh SH, Koh HT, Gee PT. Phospholipids of palm oil
(Elaeisguineensis) J Am Oil Chem Soc,1982; 59:296-299.
Katerji N, Van Hoorn JW, Hamdy A, Mastorilli M, Oweis T,
Erskine W. Response of two varieties of lentil to soil salinity. Agric.
Water Management, 2001; 47:179-190.
Kazem G-G, Minoo T-N, Shahin O, Mohammad M, Sadjad S-R.
Oil and Protein Accumulation in Soybean Grainsunder Salinity Stress. Not
SciBiol,2010; 2:64-67.
Kidd P. Phosphatidyl serine; membrane nutrient for memory. A
clinical and mechanistic assessment. Alt Med Rev,1996; 1:70-84.
Litinova ED, Arishaeva EA, Arutyunnyan NS. Phospholipids of
sunflower oil. Mao-Zhir Prom,1971; 37:13.
McWilliams DA, Berglund DR,Endres GJ. 2004. Soybean
growth and management. North Dakota State University.University of
Minnesota.
Meloni DA, Gulotta, MR, Martinez CA, Oliva MA. The effects
of saltstress on growth, nitrate reduction and proline and glycine-betaine
accumulation in Prosopisalba.Braz J Plant Physiol, 2004; 16:39-46.
Nasir Khan MH, Siddiqui M, Masroor A, Khan Naeem M.
Salinity induced changes in growth, enzyme activities, photosynthesis,
proline accumulation and yield in line seed genotypes. World J Agric Sci,
2007; 3:685-695.
Official methods and recommended practices of the American
Oil Chemists Society. 4th Edn., AOCS,1608, Broadmoor Drive,
Champaign/ Illinois-61826, USA 1990 (Reapproved 1993).
Parsons J, Keeney P, Patton S. Identification and Quantitative
Analysis of Phospholipids in Cocoa Beans. J Food Sci,1969; 34: 497-499.
Paulose M, Rao V, Achaya K. Nature of castor seed
phospholipids. Indian Journal of Chemistry, 1966; 4:529-532.
Prasad R, Rao V. Phospholipid composition of Salvadoran
oleoideas (Khakan) seeds. J. Oil Technol Assoc India, 1979; 11:35-38.
Prasad R, Rao V. Phospholipid composition of neem seeds. J
Oil Tech Assoc India, 1981; 13:101-104.
Prasad R, Rao Y, Rao V. Phospholipids of Palash (Butea
monosperma), Papaya (Carica papaya), Jangli Badam (Sterculia foetida),
Coriander (Coriandrum sativum) and Carrot (Daucus carota) seeds. J
Amer Oil Chem Soc, 1987; 64:1424-1427.
Schneider M.1989.In lecithins: Sources, Manufacture and Uses.
American Oil Chemical Society Champaign III.109-130.
Sosulki P, Zadernowski R, Babuchowski.IComposition of polar
lipids in rapseseed.J Am Oil ChemSoc,1981; 58:561.
Spiers PA, Myers D, Hochanadel GS, Lieberman HR,
Wurtman R. Citicoline improves verbal memory in aging. Archives of
neurology, 1996; 53: 441-448.
Thomas JMG,Boote KJ, Allen LH, Gallo-Meagher M, Davis
JM. Seed physiology and metabolism: Elevated temperature and carbon
dioxide effects on soybean seed composition and transcript abundance.
Crop Sci, 2003; 43:1548-1557.
Vijayalaxmi B, Rao SV, Achaya KT. An analysis of yield
components in safflower.FetteSeifenAnstrichmittel, 1969; 1:757.
Wagner H, Wolff P. Isolation and Analysis of Plant
Phosphatides and SphingolipidesFetteSeifenAnstrichmittel.1964; 66:425.
Yan L. Effect of salt stress on seed germination and seedling
growth of three salinity plants. Pakistan J Bio Sci, 2008; 11:1268-1272.
Zlatanov M, Menkov N. Phospholipid and fatty acid
composition of tobacco seeds.RostlinnaVyroba, 2000; 46:429.

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