

## A REVIEW ON NELUMBO NUCIFERA GAERTN.

PULOK K. MUKHERJEE, R. BALASUBRAMANIAN, KAKALI SAHA, B.P SAHA  
and M. PAL

Department of Pharmaceutical technology, faculty of engineering and technology,  
Jadavpur University, Calcutta – 700 032.

---

Received: 23 June, 1995

Accepted: 27 January, 1996

---

**ABSTRACT:** *Nelumbo nucifera Gaertn* (Family- Nymphaeaceae) is a well known plant in ancient medical sciences, Much research have been done on the leaves, flowers, seeds and rhizomes of the plant, Our present aim is to review all the work performed on the plant to get a clear idea to evaluate its various medicinal principles relating to phytochemical pharmacological microbiological and allied approaches.

### INTRODUCTION

*Nelumbo nucifera gaertn.* (Fam: Nymphaeaceae) is a large aquatic herb with stout creeping yellowish white colored rhizomes, Ancient medical literature assigned the Sanskrit name 'Kamala' to nelumbonucifera, there are two forms-one with white flowers commonly called 'Pundarika' or sveta kamala' and the other with pink or reddish pink flowers called 'Rakta Kamala'<sup>1</sup>.

Every part of the plant has distinct name and almost all parts are used medicinally supplying one or more drugs, the whole plant with flowers is known as 'Padmini' the rhizome is known as 'Kamalakand' the tender leaves as 'Sambartika' the peduncle as 'mrinal' or Visa', the stamens as 'Kirijalaka' the torus as 'Padmakosa' the seeds as 'Karnika' or 'Padmaksya' and the honey formed in the flowers by the bees feeding upon padma is known as 'Makaranda' or 'Padma- Madhu'<sup>2</sup>.

*N. nucifera* is a native of china, Japan and India. It is commonly found growing in

ponds, tanks and jheels; it is often cultivated for its elegant, sweet scented flowers which is called as the 'National flower of India'. Lotus is cultivated in china and Japan. In terraced fields for its edible rhizomes and seeds<sup>3</sup>.

Leaves, flowers, rhizomes, roots, fruits and seeds of *N. nucifera* has been claimed to possess various medicinal values, review. Review on all of these parts is being performed hereunder.

### Leaves

Leaves are large, of both types, aerial as well as floating orbicular 20-90 cm. in diameter, abruptly acute to form a short tip, petiolate, entire glaucous, non-wettable, strongly cupped in case of aerial leaves and flat in case of floating ones, radiately nerved, the fresh leaves are leathery, but on drying they are nearly membranous and brittle, there is more or less brownish red blotching on the lower surface, petioles of the aerial leaves are erect and stout white those of the floating ones are not strong enough. The usual length varies from 24.00

to 33.00 cm. in case of aerial leaves and 23 to 30 cm in case of floating, petioles are smooth, greenish or greenish brown in color with small brown dots sometimes rough with very small, but distinct prickles, odour is distinct, fracture is fibrous. When transversely cut, the petiole of leaf stalk always shows four distinct, large cavities in the centre and small cavities in the periphery<sup>2</sup>.

Leaves and petioles contain nor-nuciferine (I), (m.p 186-189° C, C<sup>18</sup>H<sup>9</sup>O<sup>2</sup>N, [X]<sup>18</sup><sub>D</sub>209.6°), nuciferine (II), (m.p 164-165°c, [X]<sup>22</sup><sub>D</sub>, - 215°), remerine (HI salts, m.p 224-227°c) and remerine (III), (m.p 100-101°c, [X]<sup>22</sup><sub>D</sub>-72.5°), (+) armapavine (IV), (m.p 139-140°c, [X]<sup>25</sup><sub>D</sub>-91°), were isolated<sup>4-9</sup>.

Two serotonin antagonistic alkaloids were isolated from leaves of *N. nucifera* like asimilobine and lirinidine. Both alkaloids inhibited contraction of the rabbit isolated aorta induced by serotonin. One more alkaloid nelumbine was also reported to be present in leaves and petioles of the plant which acts as a cardiac poison<sup>3</sup>.

The leaves also contain nelumboside, a glycoside which on hydrolysis with 5% H<sub>2</sub>SO<sub>4</sub> gave one molecule of quercetin, glucose and glucuronic acid, On methylation with CH<sub>2</sub> N<sub>2</sub> followed by hydrolysis this glycoside gave 5,7,3', 4' tetra-ortho-methyl-I quercetin, M.p 192°C<sup>11</sup>. The leaves also contain iso-quercetin, and leucoanthocyanidin which were identified as leucocyanidin and leucodelphinidin by conversion into corresponding anthocyanidin chlorides or by paper chromatography or by absorption maxima<sup>12</sup>.

Leaf, pedicels contains alkaloid nelumbine, alkaloid nupharine in 8mg/kg dose to a dog causes lasting stimulation of respiration;

impaired respiration is restored and stimulated<sup>13</sup>.

## Fruits and Seeds

Fruit is an aggregate of indehiscent nut-lets. Ripe nutlets are aoid, roundish or oblongish upto 1.0 cm long 1.5 cm broad, with hard smooth, brownish or grayish black pericarp which is faintly longitudinally striated, pedunculated and one seeded. Seeds fill in the ripe carpe<sup>12</sup>.

Fruits of *N. nucifera* have remarkable power of dormancy and indeed the proved longevity of its seeds exceeds that of any known species of flowering plant Robert brown, first keeper of botany in the british museum, experimented with fruits of Nelumbo at various times between 1843-1845 showed that they retained the power of germination after 150 years of confinement in glass-topped box<sup>14</sup>.

A large amount of glutathione is contained in the plumule (13/plumule) and cotyledons (164/cotyledon) of *N. nucifera*, the amount of total plumule in the maturing seed increases gradually. The reduced form of glutathione is dominant in the early stages, while the amount of oxidized form exceeds that of the reduced form at the end of maturation. The amount of reduced form of glutathione in the unripe fruit decreases markedly upon storage for 1 year. In general the rate of germination of the stored seeds seems to be closely related to the content of the reduced glutathione<sup>15</sup>.

Several alkaloids have been isolated from the seeds of *N. nucifera*, The loti embryo (Lien Tze Hsin) of continental china was found to contain liensinine (V) and isoliensinine (CI) from one of the formosan lotus and both isoliensinine (VI) and neferine (VII) were isolated from Lien Tze

Hsin in Hong Kong market,)-methyl neferine (VIII) (symphnate, m.p 139-140°C, [X]D -93.3° acetone) was found to completely identical with the synthesized 0.0-demethylisoliensinine. When) – ethylneferine (IX) was subjected to the cleavage reaction by metallic sodium in liquid ammonia, P-1,2,3,4 – tetrahydro -6 methoxy-1-(p-methoxy- benzyl) -2-methyl-7- isoquinolinol (X) and D-(-) -3-bromo –O – Methyl- armepavine (XII) were obtained, therefore, it has been verified that the structure of neferine was represented by the formula<sup>16-21</sup>.

A new water soluble quarterary base was isolated from lotus embryo besides the earlier reported besides the earlier reported isoliendinine, It was named as lotusine, it was found to be present in the form of a chloride (m.p 213-215°C), a picrate (m.p 212-214°C) and iodide (m.p 202-204°C) which is identical with D-N methyl isocuclaurine methiodide<sup>22-26</sup>.

Another variety of *N. nucifera*, *N. speciosum* seeds contained 2.11% oil examined by gas chromatography, urea adductation and UV absorption revealed the presence of myristic acid (0.04%), palmitic acid (17.32%), oleic acid (21.91%), Linoleic acid (564.17%) and linolinic acid (6.19%)<sup>27,28</sup>.

The alkaloids of lotus embryo was found to possess hypotensive effect<sup>29</sup>. The seeds are used to check vomiting, given to children as diuretic and refrigerant form a cooling medicine for skin diseases & leprosy; considered as antidote to poisons<sup>13</sup>. The essential oil contained in the seeds of *N. speciosum* willd. Were found to possess good aphrodisiac affect and possess pronounced nutritive value<sup>30</sup>.

Lotus seeds (*Lien Tzu*), the “beans” that Pythagoras was said to have once forbidden his disciples to eat, constitute another delicacy found in the chirmatown food shops, they are produced by the Chinese lotus, *N. speciosum* willd, and are about the size of a marble, white after the coverings are removed they are eaten raw, candied, roasted boiled or ground into flour and are considered nourishing and highly beneficial to bodily health and strength in promoting circulation and strengthening cirilityu<sup>31</sup>.

## Flowers

Solitary, large, 10-25 cm in diameter, white pink or pinkish white fragrant peduncles arising from the nodes of the rhizomes, sheathing at the base, 1-2 cm long, green or blackish green, hard and stout, smooth or rough due to the presence of numerous small scattered prickles, sepals, petals and stamens are spirally arranged passing gradually one into another<sup>32</sup>.

The ether and aqueous of the petals, stamens and torus of *N. speciosum* gave typical color reactions for flavanoids, the concentrate from the enter extract on ascending and descending paper chromatography showed the presence of quercetin and luteo (confirmed by column chromatography) in the case of petals and stamens, only quercetin was present in torus, the aqueous extract on further concentration showed the presence of iso-quercetin and glucoluteolin in the case of petals and stamens while the torus contain only iso quercetin. The sugar was identified in each case as glucose only by paper chromatography and the osazone<sup>12</sup>. The flowers also contain a glycoside kaempferol (kaempferol- 3- galacto-rahmno glycoside)<sup>33</sup>.

The powdered sun-dried flowers of *N nucifera* as well as the aqueous and

alcoholic extract of these, produced significant hypoglycaemia in fasting normal albino rabbits, the effect was approximately 50% that produced by 250 mg/kg of tolbutamide, In normal rabbits, the extract at a dose of 1000 mg/kg of the sun-dried flowers significantly depressed hyperglycaemia induced by injection of adrenaline hydrochloride 0.5mg/kg s.c<sup>34</sup>. In vitro studies with rat hemidiaphragms revealed that the test drug (sun-dried flowers powdered) treatment of donor animals significantly enhanced the effect of insulin. The improvement of glucose tolerance therefore may also be due to increased peripheral glucose utilization caused by increased sensitivity of skeletal muscle to endogenous insulin<sup>35</sup>.

The stalks of *N. nucifera* Gaertn. Have been used as one of the ingredients of Madhucasava, a unique fermenting medium, used for the micro-biological screening<sup>36</sup>. the flowers has cooling effect, used as astringent in diarrhea, also in cholera, in fever and diseases of liver, recommended as a cardiac tonic<sup>13</sup>.

The flowers of *N. nucifera* are used for ornament and as offerings in temples, they are used as a source of perfume. The honey from lotus flowers is reported to possess tonic properties and considered useful for affections of the eye<sup>3</sup>. Garlands made from the beautiful, fragrant white or rose flowers are used for decoration and in the worship of goddess lakshmi, the symbol of wealth<sup>37</sup>.

### Rhizomes

The rhizomes are 60-140 cm long 0.5 to 2.5 cm in diameter, yellowish white to yellowish brown in color, smooth longitudinally striated with brown patches, Nodes and internodes are present. When freshly cut is exudes mucilaginous juice and

show a few large cavities surrounded by several larger ones, fracture is tough and fibrous. Odour is indistinct<sup>2</sup>.

Abundant starch grains are present throughout the tissue, Alkaloids sterols and reducing sugars have been detected on preliminary phyto-chemical study form various extract of rhizomes<sup>38</sup>.

Fresh rhizomes are analysed and it contains the following constituents:

Water – 83.80%	Fat – 0.11%
Reducing Sugar- 1.56%	Crude Starch- 9.25%
Sucrose – 0.41%	Ash – 1.10%
protein – 2.70%	Calcium- 0.06%
Fibre-0.80%	

The vitamins are reported to be present are as follows (in mg/100g)

Thiamine – 0.22
Riboflavin – 0.06
Niacin – 2.1
Ascorbic acid – 1.5

The rhizomes also contains asparagines (2%). The oxalate contents of lotus rhizomes was found to be 84.3mg%<sup>39</sup>.

Fresh rhizomes are eaten after roasting, white dried slice are used in curry or fried as chips. They are also pickled<sup>3</sup>. Methanolic extract of the rhizome has been found to possess significant hypoglycemic activity on streptozotocin induced significant

hypoglycemic activity on streptozotocin induced diabetic rats<sup>40</sup> and it has also been found to have significant psychopharmacological effect and alteration in general behavioural pattern<sup>41</sup>.

Tinctures of rhizome has been prepared by using different strengths of alcohol. 50% (V/V) alcohol has been found to extract in maximum amount of the constituents present; evaluation and standardization of different strengths of tinctures has been made.<sup>42</sup>

Powdered rhizomes is prescribed for piles as demulcent, beneficial in dysentery and chronic dyspepsia, External application in the form of paste is useful in scabies and ring worms Rhizomes yield a kind of nutritious arrowroot given to children for dysentery and diarrhoea<sup>43,44</sup>.

%concentration of various elements in *N.nucifera* predried at 150° were Ca-1.15, Cu-0.0015, Fe-0.053, Mg-0.398, Zn-0.0032, Ba-0.00064K-0.756, Na-0.10<sup>45</sup>.

gelatinization property of lotus root starch has been confirmed by characterizing with a microscope heating-stage and differential scanning colorimetry<sup>46</sup>.

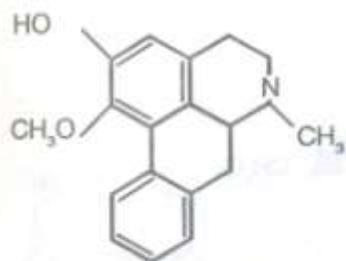
## CONCLUSION

It is obvious from this review that *N. nucifera* (Kamala or Pundarika) is used in ayurvedic medicine from early times, so many works has been performed on the leaves, flowers, seeds, fruits rhizomes, copious references regarding the phytochemical pharmacological and microbiological aspects of different parts of this plant are available, some of the properties mentioned in the ancient medical literature need exploitation.

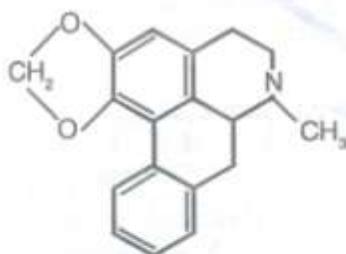
## ACKNOWLEDGEMENTS

Authors are thankful to Amal Kumar Maiti and S. venkatesan for their preparation of the review. Financial support from C.S.I.T., New Delhi, for the project entitled “Studies on Rhizomes of *N. nucifera*” to Pulok K, Mukherjee is gratefully acknowledged.

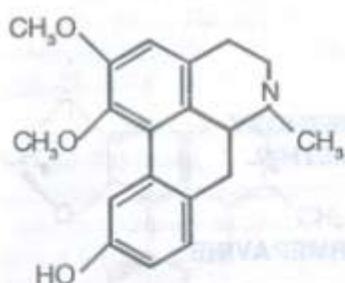




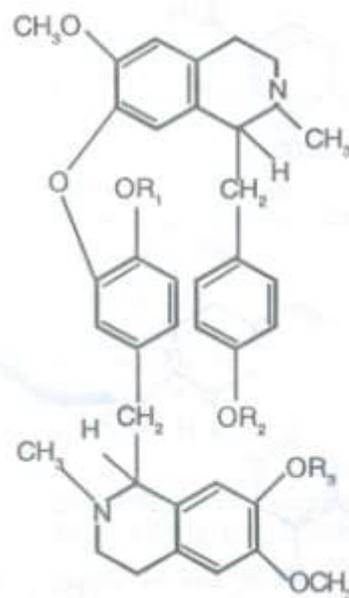
**I NOR NUCIFERINE**



**III ROEMERINE**



**IV(+) ARMEPAVINE**



**V LIENSININE**  $R_1, R_2 = H$

$R_3 = CH_3$

**VI ISOLIENSININE**

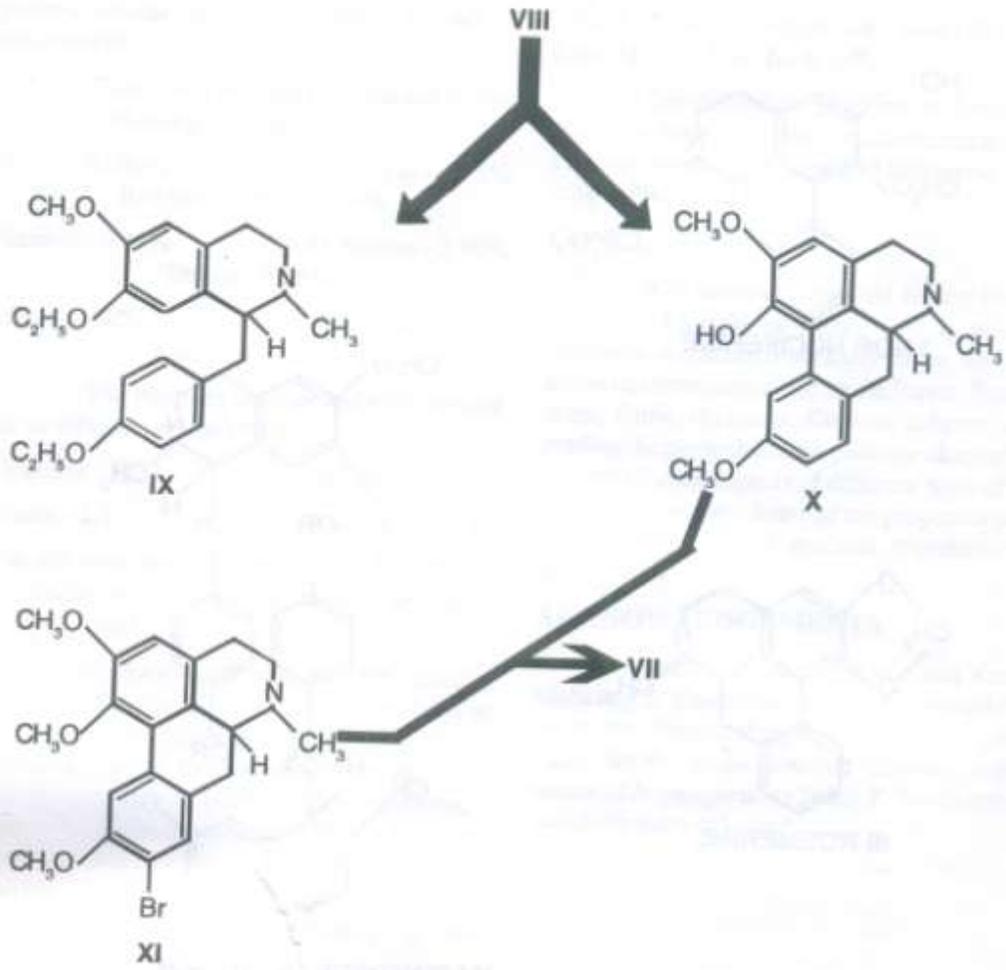
$R_1, R_3 = H$

$R_2 = CH_3$

**VII NEFERINE**

$R_1, R_2 = C_2H_5$

$R_3 = CH_3$



**IX** O-ETHYL NEFERINE

**X** P-1,2,3,4 - TETRAHYDRO-6-METHOXY  
-1-(P-METHOXY BENZYL)-2-METHYL  
-7- ISOQUINOLINOL

**IX** D(-)-3'-BROMO-O-METHYL-ARMEPAVINE

## REFERENCES:

1. Chopra, R.N., Chopra, I.C and Handa, K.L “Indigenous drugs of India” U.N. Dhur and sons Pvt Ltd Calcutta, 2<sup>nd</sup> Edn., 679, (1958).
2. Anonymous, “Pharmacognosy of indigenous drugs” C.CR.A.S New Delhi, Vol 11, 806, (1982).
3. Anonymous “ The Wealth of India”, Vol III,P.ID., CSIR, New Delhi 7(1966).
4. Tomita, M.et al., Alkaloids of Nelumbo nucifera III. Alkaloids of Nelumbo nucifera var, prolifera Chem Abstr., 56(4), 2564f, (1962).
5. Tomita, M.et al., Alkaloids of Nelumbo nucifera I. Chem Abstr., 55(18), 180 15d, (1961).
6. Tomita, M.et al., Alkaloids of Nelumbo nucifera IV. Isolation of dlarmepavine. Chem Abstr., 56(4), 2564f, (1962).
7. Tomita, M., Alkaloids from Nelumbo nucifera Chem Abstr., 59(6), 620c, (1963).
8. Arthur. H.R & Cheung, H.T Aporphine alkaloid nuciferine, from a species of lotus cultivated in Hong Kong., Chem. Abstr., 53 (20), 19306g (1959).
9. Kupchan, S.M Dasgupta, B., Fuita, E and King, ML., The Alkaloids of American Lotus Nelumbo Lutea, tetrahedron, Vol 19,227 to 232, (1963).
10. Shoji N., Umeyama, A., Saito N., Luchi A. and Takemoto, T., Asimilobine ad Lirinidine, serotonergic receptor antagonists from Nelumbo nucifera, J Nat products (Lloydia), 50(4), 773-774, (1987).
11. Nakaoki T.et al., Medicinal resources, XIX. Flavonoid of the leaves of Nelumbo nucifera, chem. Abstr. 56(2), 1527d, (1962).
12. Nagarajan, S., Nair A.G.R Ramkrishnan S. and Subramanian, S.S., Chemical examination of the flowers of Nelumbium speciosum willd, current science, 35(7), 176, (1966).
13. Chopra. R.N., Nayar and chopra I.C., “Glossary of Indian medicinal plants”, CSIR, New Delhi, 174, (1956).
14. Sherriff George and Taylor George., J. Roy Horti Soc., 73(216-217, (1948).
15. Toyoda, K. Glutathione in the seed of Nelumbo nucifera, chem. Abstr., 65(7), 10959f, (1966).

16. Furukawa, H., On the alkaloids of *Nelumbo nucifera* Gaertn., X Alkaloids of Loti embryo. (3) Domestic "Lien Tze Hsin" International pharmaceutical abstracts, 3(7) 403b, (1966).
17. Furukawa, H., On the alkaloids of *Nelumbo nucifera* Gaertn., IX Alkaloids of Loti embryo. (3) Domestic "Lien Tze Hsin" International pharmaceutical abstracts, 3\*7) 403e, (1966).
18. Tomita, M et al., Alkaloids of Loti embryo.,I structure of isoliensinine., Chem. Abstr., 61 (13), 16108f, (1964).
19. Tomita, M and furukawa, H. studies on the alkaloids of Loti Embryo Tetrahe- dron letters, 37, 2637-2642, (1964).
20. Chao, Y.C et al., Alkaloids of embryo *Nelumbo nucifera*. I Isolation and characterization of liensinine., Chem. Abstr., 57(6), 7383i, (1962).
21. Guo M., Chen L., Studies on the alkaloid constituents of the embryo nelumbini., (*Nelumbo nucifera*) produced in china., zhongcaoyao, 15(7), 291-93, (1984).
22. Furukawa, H., Alkaloids of *Nelumbo nucifera*. XI. Alkaloids of *Nelumbo nucifera* embryo. 4. structure of lotusine, a new watersoluble quaternary base., Chem Abstr., 63(5), 5692c, (1965).
23. Guo M., Chen L., Studies on the alkaloid constituents of the embryo nelumbini., (*Nelumbo nucifera*) produced in china. Abstr., 101(23), 355,207624f, (1984).
24. Chao, Y.C et al., Alkaloids of embryo *Nelumbo nucifera*. I Isolation and characterization of liensinine., Sci. Sinica (Peking),11, 215-19 (1962).
25. Furukawa, H., Studies on the alkaloids of *Nelumbo nucifera* Gaertn., XII NMR (Nuclear magnetic Resonance) of liensinine type alkaloids., Biol Abstr., 48(8), 3679, Abstr., 40828, (1967).
26. Furukawa, H., On the alkaloids of *Nelumbo nucifera* Gaertn., XII Alkaloids of Loti embryo.5., Biol Abstr., 47(13), 5492, Abstr., 64402,(1966).
27. Gangrade, H.H &I ushal, R Composition of the of nelumbium speciosum willd seeds, chem. Abstr., 98(11) 304, abstr., 8630j (1966).
28. Dhar, D.N and Munjal, R.C Chemical constituents of the seeds of *Nelumbo nucifera* current science, 41(2), 59, (1972).
29. Chao, T.et al., Studies on the Alkaloids of embryo *Nelumbo nucifera* Gaertn., I Isolation and characterization of liensinine., Biol. Abstr., 40(2), 605, abstr., 8131, (1972).

30. Puri H.S., Vegetable aphrodisiacs of India, *Quart. J crude Drug Res* 11(2), 1742-48, (1971).
31. Porterfield, W.M., The principle chines vegetable foods & food plants or china town, *Econ. Botany*. Vol 5(1), 10, (1951).
32. Gupta S.C and Ahluwalia, R J. *Indian Botanical society*, 58(2), (1979).
33. Nagarajan, S., Nair A,G.R Ramkrishnan. S. and Subramanian, S.S., Flavonoids of the flowers of *N. speciosum*, *The Indian journal of pharmacy*, 27(3), 89,(1965).
34. Huralikuppi J.C., Christopher A.B and Stephen P.M antidiabetic effect of *Nelumbo nucifera* (Geartn): part-I Pre-liminary studies in rabbits, *pytotherrapy research*, 5(2), 54-58 (1991).
35. Huralikuppi J.C., Christopher A.B and Stephen P.M antidiabetic effect of *Nelumbo nucifera* (Geartn): part-II I, *ibid*, 5(5), 217-223 (1991).
36. Alam, M., Rani G., Sathavasan, K, Dasan, K.K.S and purushothaman, K.K Microbiological screening of *Madhuca* flowers *jour. Res Ayr Sid.*, V. 1-4, 75-81, (1984).
37. Mehra, K.L., et al, Folk uses of plants for adornment in India, *economic botany*, 29(1) 39-46, (1975).
38. Mitra, R., Mehrotra, S. and Kapoor, L.D pharmacognostical studies on the rhizomes of *N. nucifera* the ind J of pharmacy 35(6), 207-208, (1973).
39. Kaul, S. and Verma S.L Oxalate contents of foods commonly used in Kashmir Indian. *J Med Res.*, 55(3), 274 – 278 (1967).
40. Mukherjee, P.K Pal, S.K and Saha B.P Pharmacognostical phytochemical and pharmacological studies on eh Rhizomes of *Nelumbo nucifera* geartn (Fam Nymphaeaceae), *Scientific abstracts Indian pharmaceutical congress*, F9, (1992).
41. Mukherjee, P.K Pal, S.K and Saha K., Saha B.P Pal, M., Venkatesan, S and Balasubramanian, R., studies on behavioral effects of *Nelumbo nucifera* Rhizomes Extract in animal, *Scientific abstracts Indian pharmaceutical congress*, C-26, 144, (1994).
42. Mukherjee, P.K Pal, S.K and Saha K., Saha B.P studies on some Co-chemical properties of tinctures of *Nelumbo nucifera* geartn (Fam Nymphaeaceae), *Research and industry*, 38, 264-265, (1993).
43. Chatterjee, A and pakrashi S.C., “The treatise on Indian medicinal plants”, publications & Information directorate, New Delhi, Vol I, 94-96, (1991).
44. Kirtikar, K.R and Basu, B.D., “Indian Medicinal plants”, 2<sup>nd</sup> Edition, 116-120, (1975).

45. Jain, N., Magan K.A and Sondhi S.M., Determination of mineral elements present in medicinal plants used for the development of health, for the treatment of cough and vomiting pyorrhea, rheumatic and allied disorder, Indian Drugs, (30)5, 190-194, (1993).
46. Shi-Ying Xu and Charles F. Shoemaker., gelatinization properties of chines water chestnut starch and lotus roots starch journal of food science, 51(2), 445-449. (1986).