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Review Article

A REVIEW ON POTENTIAL OF PLANTS UNDER TRAPA SPECIES

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ABSTRACT

Medicinal plants are widely used by the Traditional Medical Practitioners for counteracting various diseases in their day to day practice. Plants of *Trapa* species (family: Trapaceae or Lythraceae), commonly known as 'Water chestnut' or 'Water caltrop' in English, are floating annual aquatic plants, growing in slow-moving water up to 5 meters deep. They are native to warm temperate parts of Eurasia and Africa. According to the International System of Medicines, different parts (leaves, stem and seeds) of the plants and even whole plants are used traditionally for several medicinal purposes. The juice of the fruits has been used for the treatment of diarrhea and dysentery; the plants are also used to combat fever, leprosy, fatigue, inflammation, urethrorrhea, fractures, erysipelas, lumbago, pharyngitis, bronchitis and general debility. Thus this review will be lead to break through for exploration of this species for its therapeutic potential.

Keywords: *Trapa* species, traditional use, pharmacognostical investigation pharmacological use.

INTRODUCTION

Water caltrop(Singara) is one of the most popular vegetables used in Asia, due to its special feature and medicinal values which ; it is found in Taiwan, China and parts of South East Asia[1]. The Singhara nut is a valuable agricultural product, commercially cultivated in many parts of India, particularly in the Eastern and Southern regions[2]. Singhara is extensively grown in Uttar Pradesh, Madhya Pradesh, Bihar and Orissa, where high rainfall is conducive to successful cultivation[3]. It contains carbohydrates, minerals, calcium, phosphate, iron, copper, manganese, magnesium, sodium and potassium. The kernels contain some vitamins like thiamine, riboflavin, nicotinic acid, vitamin C, vitamin A, D-amylase and considerable amount of phosphorylases[4]. It is used in many Ayurvedic preparations as nutrient, appetizer, astringent, diuretic, aphrodisiac, tonic, cooling and antidiarrheal agents. It is also useful in lumbago, sore throat, bilious affections, bronchitis, fatigue and inflammation. The medicinal values of the whole herb and fruit have long been recognized in folklore medicine as a cure for various diseases[5]. The whole herb has been reported for hepatoprotective activity[6], antimicrobial activity, antibacterial activity[7] antitumor activity[8], antioxidant activity[9] and free radical scavenging activity[10]. Further, the fruits have been used as intestinal astringent, aphrodisiac, anti-inflammatory, antileprotic agent and in urinary discharges, fractures, sore throat, bronchitis and anemia[11, 12]. In addition to this, the juice of the fruit has been used for diarrhea and dysentery[13]. Fruits are also being used in making liniments for the cure of rheumatism, sores and sunburn. It is also said to have cancer-preventing properties. Stem juice is used in ophthalmic preparations[14, 15]. Due to high activity of enzymes and phenolic contents, the color of water caltrop hulls easily changes from original pink to dark brown during transportation and processing[16].

History

Water chestnut had been introduced from Europe as an ornamental plant. Dispersal is limited because of the large, sinking nuts, but Water chestnut has persisted and spread in the

Northeastern states. In the Chinese Zhou Dynasty, water caltrop was an important food for worship as prayer offerings. The Rites of Zhou (2nd century BC) mentioned that a worshipper should use a bamboo basket containing dried water caltrops. In India it is known as Singhara or Paniphal (Eastern India) and is widely cultivated in fresh water lakes. The fruits are eaten raw or boiled. When the fruit has been dried, it is ground to a flour called singhare ka atta which is used in many religious rituals and can be consumed as a phalahar diet on the Hindu fasting days, in Navratas[17].

Vernacular names[18]

- English: Water chestnut, Caltrop, Singhara nut,
- Hindi: Simghara, Singhada
- Kan: Singhara
- Malyalam: Karimphola
- Sanskrit: Shningataka
- Tamil: Cimkhara
- Tel: Kubjakamu

Taxonomy

The genus *Trapa* is currently placed in the family Lythraceae (Purple loose strife family; Angiosperm phylogeny group 1998), although previously segregated as the Trapaceae or Hydrocaryaceae. Some authors have split *Trapa* into numerous species distinguished by minute differences in the morphology of the fruits [Fig. 1(b)]; Shishkin and Bobrov (1974) listed 25 species for the Union of Soviet Socialist Republics (U.S.S.R) alone. Most Botanists now recognize one species, *T*. *natans*, comprising of two varieties: *T. natans* var. *natans* L. and *T. natans* var. *bispinosa* Roxb. (Integrated Taxonomic Information System, 2003). *Trapa natans* var. *natans*, the water chestnut, water-nut, or water caltrop are now widely distributed in Eurasia, Africa and in North Eastern United States, which bears as a four-horned fruit[19] ,whereas *T. natans* var. *bispinosa* Roxb. *(Trapa bicornis* Osbeck*, T. bicornuta* L.*, and T. japonica* Fler.) called as the Water chestnut, Singhara nut, or Bull nut. It is found in China, Japan, India, and South East Asia which produces a fruit with two stout curved horns as shown in Fig. I [20] .

Cultivation and collection

It is commercially cultivated across different parts of India for its consumable seasonal fruits. Water caltrop (*Trapa Taiwanensis* Nakai) belongs to the family Trapaceae, one of free-floating plants grown in shallow water fields, ponds or swampy lands in tropical and sub-tropical countries[21, 22]. It is a water plant,which grows in water up to 60 cm deep and , requires a sunny position in slightly acidic water. In spring, *Trapa* is cultivated by placing one seed in each pot and submerging them under a few centimeters of water[23-25]. Water chestnut is restricted to fresh water, because its seeds fail to germinate when NaCl concentrations exceed 0.1%. The plant is also intolerant to $Ca(HCO_3)_2$ and $Mg(HCO_3)_2$ [26]. For growing, Water chestnut requires full sun, sluggish, nutrient-rich, fresh waters and soft substrates. Seeds are stored in winter in a jar of water in a cold, but frost-free place. The seeds quickly lose their vitality, if they are allowed to become dry[27].

Plant description

Trapa is an aquatic floating plant with flexuose ascending stem and green photosynthetic submerged root, leaving simple alteration, crowded at the upper part of the stem in rosettes [Fig. 1(a)], rhomboidal, apex triangular, irregular inciso–serrate in the upper part a dark green above, radish purple beneath, petioles dilated near the apex into a large spongy float, flowers white, opening above the surface of water in the afternoon, axilary and solitary. Fruits are ovoid bony, angular with short conical beak in the centre at the apex and a spreading, flattened, very sharp spinous horn on the other side, indehiscent, one seeded, seeds while starchy [Fig. 1(b)][28].

Chemical constituents

Trapa contains a great quantity of non-nutritional antioxidants, such as flavoniods, flavone and total phenolic contents. Flavonoids are present in plant tissues, such as fruits, vegetables, nuts, seeds and leaves, in relatively high concentrations. Flavonoids act as natural antioxidants. Phytochemical screening of seed extract of *T. natans* fruits reveals the presence of carbohydrates, saponins, phytosterols, fixed oils and fat while the pericarp extract of the fruits of *T. natans* revealed the presence of tannins, flavonids and glycosides[29-31]

From the hydroalcoholic extract Trapa pseudoincisa Nakai, three compounds were isolated. The chemical structures of the compounds were determined as cycloeucalenol (1), ursolic acid (2), and 2β,3α,23-trihydroxyurs-12-en-28-oic acid (3)[45] Fig. II. Chemical constituent of Trapa natans[44] Table I.

Traditional uses

The fruits are sweet, astringent, cooling, constipating, haemostatic, diuretic, aphrodisiac, antipyretic, appetizer and tonic. They are used in the vilalated conditions in pitta, burning sensation, dipsia, dyspepsia, haemorrhage, hemoptysis, diarrhea, dysentery, strangury, intermittent fever, leprosy, fatigue, inflammation, urethrorrhea, fractures, erysipelas, lumbago, pharyngitis, bronchitis and general debility[28, 32, 33].

PHARMACOLOGICAL ACTIVITIES

The following pharmacological activities have been reported on the genus

A. Antimicrobial activity

The methanolic extract of this plant at the concentration of 200 µg/disc showed a more potent antimicrobial activity against Gram positive (*Bacillus subtilis, B. cereus, B. megaterium, Staphylococcus aureus* and *Staphylococcus β-haemolyticus*) and Gram negative (*Escherichia coli, Klebsiella, Pseudomonas aeruginosa, Shigella dysenteriae, Shigella flexneri, Shigella sonnei, Shigella boydii, Salmonella typhi* A and *Salmonella typhi* B-56) bacteria than the activity shown by ethyl acetate, chloroform and petroleum ether extracts. The most significant cytotoxic activity in the brine shrimp lethality assay was observed for the chloroform extract.[34]

B. Analgesic activity

The methanolic extract of *Trapa natans* L. var. *bispinosa* Roxb. roots had shown potential analgesic activity on tested animals. Analgesic activity of the methanolic extract of the *T. bispinosa* root at a dose of 200 mg/kg and 400 mg/kg was evaluated by tail flick and tail immersion method against the standard drug Pentazocine at a dose of 30 mg/kg. The result suggest a significant analgesic activity which was observed by centrally acting drug.[35, 36]

C. Antiinflammatory activity

Fruits of *Trapa natans* L. var. *bispinosa*, commonly known as Shingoda, were reported to be potential antiinflammatory agent in traditional literatures. Antiinflammatory activity was performed by using Carrageenan induced hind paw edema model. The aqueous extract of pericarp had shown significant antiinflammatory activity by decreasing paw volume on the 3rd and the 5th hour, while the aqueous extract of seed showed significant antiinflammatory activity by decreasing the paw volume at the 5th hour only.[37]

D. Antioxidant activity

Aqueous extract of *Trapa natans* L. fruits had shown potential *in vitro* antioxidant activity. The extract was found to contain a large amount of polyphenols and also exhibited an immense reducing ability. The total content of phenolics, flavonoids and tannin compounds was estimated as 63.81 mg of gallic acid equivalents/g of dry material, 21.34 mg of rutin equivalents/g of dry material and 17.11 mg of total tannin equivalent/g of dry material, respectively. Reducing power and inhibition of OH radical-induced bovine serum albumin (BSA) oxidation were also determined. The data obtained from the study suggested that the aqueous extract of *Trapa natans* L. fruit rind had significant antioxidant activity against free radicals.[9, 32, 38]

The effect of hydroaccoholic extract of *T. bispinosa* (TB) was studied on fluorescence product and biochemical parameter like peroxidation catalase activity and glutathione peroxidase activity in brain of female Albino mice. Ageing was accelerated by the treatment of 0.5 ml of 5% D–glucose for 15 days. This resulted in increased fluorescence product showed an increase in lipid peroxidase and decrease the antioxidant enzyme like glutathione peroxides and catalase in cerebral cortex. After cotreatment with hydroalcoholic extract of TB (500 mg/kg) there was decrease in fluorescence product in cerebral cortex. Moreover, TB inhibited increase lipid peroxidation and restores glutathione peroxidase and catalase activity in cerebral cortex as compare to ageing accelerated control group. Thus the extract was found to be effective as an antioxidative agent which could reverse D-galactose induced ageing changes resulting due to oxidative damage.[39]

E. Noortropic activity

TB extract showed significant facilitatory effect on aversively investigated for its noortropic activity using various experimental paradigms of learning and memory, *viz.* transfer latency (TL) on elevated plus-maze, passive avoidance response (PAS) and object recognition test. The investigation reported that TB 500 mg/kg significantly reduced the TL on 2nd and 9th day while TB 250 mg/kg was found effective on 9th day. TB 250 and 500 mg/kg significantly increased the step down latency in the PAS at acquisition and retention test. Moreover the TB

(250 & 500 motivated learning and memory in mice as well as improvement of memory in absence of cognitive deficit. From the above experiment it was proved that the hydroalcoholic extract of TB had significant noortropic activity.[40]

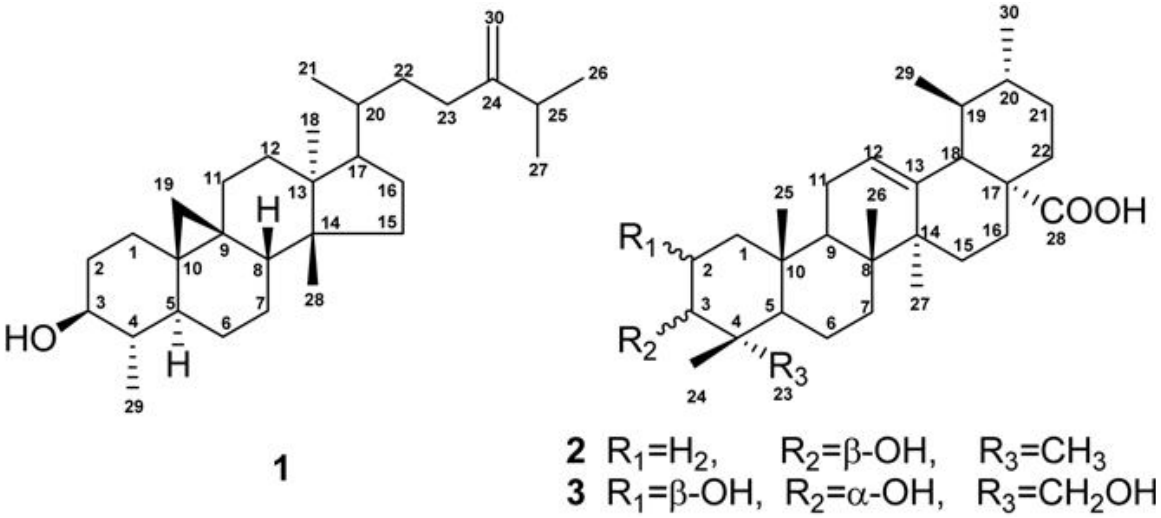
F. Imunomodulatory activity

Aqueous extract of fruits of *T. bispinosa* (TBAE) showed promising immunomodulatory function. The immunomodulatory effect was assessed in rats against sheep red blood cells (SRBC) as antigen by studying cell-mediated delayed type hypersensitivity reaction (DTH), humeral immunity response and percent change in neutrophil count. Macrophage phagocytosis assay was carried out by carbon clearance method in mice. Oral administration of TBAE dependently increased immunostimulatory responses. Delayed type hypersensitivity reaction was found to be augmented significantly ($p<0.05$) by increasing the mean foot pad thickness at 48 hr and production of circulatory antibody titre (humoral antibody response) was significantly ($p<0.05$) increased in response to SRBC as an antigen. In addition, immunostimulation was counteracted by upregulating macrophage phagocytosis in response to carbon particles. Immunostimulatory property of TBAE further **c**onfirmed by elevating neutrophil counts significantly ($p<0.01$), as compared to control. The results of the present study suggested that the aqueous extract of fruits of *T. bispinosa* could stimulate the cellular and humoral response in animals.[41, 42]

G. Antidiabetic activity

Antidiabetic activity of methanolic extract of *T. napans* fruit peels (METN) was studied in Wistar rats. The effect of METN on oral glucose tolerance and its effect on normoglycemic rats were studied. Diabetes mellitus was induced in rats by single intraperitonial injection of Streptozotocin (STZ, 65 mg/kg body weight). Three days after STZ induction, the hyperglycemic rats were treated with METN orally at the dose of 100 and 200 mg/kg body weight daily for 15 days. Glibenclamide (0.5 mg/kg body weight, orally) was used as reference drug. The fasting blood glucose levels were measured on every 5 days during the 15 days treatment. METN, at the doses of 100 and 200 mg/kg, was found to be orally significant ($p<0.001$) and dose dependently improved oral glucose tolerance, exhibited hypoglycemic effect in normal rats and ant diabetic activity in STZ-induced diabetic rats by reducing and normalizing the elevated fasting blood glucose levels as compared to those of STZ control group. *T. natans* fruit peel demonstrated promising antidiabetic activity in STZ-induced diabetis in Wistar rats[43-45]

Fig. 1: Morphology of (a) aerial part and (b) fruits of *Trapa* plant



1

2 $R_1=H_2$, $R_2=\beta$-OH, $R_3=CH_3$

3 $R_1=\beta$-OH, $R_2=\alpha$-OH, $R_3=CH_2OH$

Fig. II: Chemical structures of triterpenoids from the whole plant of T. pseudoincisa

Table I: Chemical composition of Trapa natuns

Constituent	percentage
Moisture content	81.12±0.5
Total soluble solid	7.2 ±0.2
Total acidity	0.142±0.03
Total ash	1.36±0.04
Crude lipid	0.72±0.02
Total Protein	1.87±0.03
Total Sugar	5.36 ±0.04
Reducing Sugar	1.27±O.O2
non reducing sugar	4.36±0.03

CONCLUSION

Trapa, the aquatic floating plant, has been used as food product as well medicinal product all over the world. The traditional healers use the Singhara Ata *(Trapa natans)* in combination with sugar internally in various treatments. As per the use of traditional medicines, the fruits are sweet, astringent, cooling, constipating, haemostatic, diuretic, aphrodisiac, antipyretic, appetizer and tonic. Now the recent researches have proved that the *Trapa* species posses promising antioxidant, immunomodulatory, noortropic and anti-diabetic activities. Though it has a various positive pharmacological effect ,but it is the need of hour to explore its medicinal value at molecular level with the help of various biological tools and techniques . After reviewing the above study, it is conclude that the isolation of the active compound(s) of this plant species should be explored and should be studies for its molecular mechanism of interaction with various compound(s) present with in the with human body to treat different disease .

Thus this information will lead to all the possible activities conducted for its authentificity which will be differentiated by other allied drugs.

REFERENCES

1. Herklots GAC. Vegetables in South-east Asia. George Allen & Unwin publisher; London, U.K 1972;2nd Edn: 261–462.
2. Mazumdar BC. Water chestnut-the aquatic fruit. Agriculture International Series 1985; 32(2):42-44.
3. Little ECS. Handbook of utilization of aquatic plants: A review of world literature. United Nations; 1979.
4. Crow EC and Hellquist C B. Aquatic and Wetland Plants of Northeastern North AmericaVol.I.Dicotyledons. University of Wisconsin Press, Madison, Wisconsin.2000;480.
5. Rahman MM, Wahed MI, Biswas MH, Sadik GM, Haque ME. In vitro antibacterial activity of *Trapa bispinosa Roxb*. Science 2001; 1: 214-246.
6. Kar D, Snigdha P, Maharana L, Dash G. Hepatoprotective activity of water chestnut

fruit. Indian Journal of Natural Products 2002; 3: 17-21.
7. Rahman MM, Mosaddik MA, Wahed MI, Haque M E. Antimicrobial activity & cytotoxicity of *Trapa bispinosa* . Fitoterapia 2000; 71(6): 704-706.
8. Irikura T, Masuzawa K, Tanaka N, Hasegawa Y, Kawasaki H. Antitumor steroids from *Trapa* fruits. Japanese Kokai Tokkyo Koho 1972; 47(41):522-523.
9. Song MC, Yang HJ, Bang MH, Kim DK, Jeong TS, Kim JP. Antioxidant and antiatherogenic activity of cis-Hinokiresinol from *Trapa pseudoincisa.* Arch Pharm Res 2007 Nov; 30(11):1392-1397.
10. Kim B, KimJ, KimH and Heo M. Biological screening of 100 plant extracts for cosmetic use: anti-oxidativeactivity and free radical scavenging activity. International Journal of Cosmetic Science 1997 ;19 (6): 299-307.
11. Kirtikar KR, Basu BD. Indian medicinal plants. 2nd edn. Vol III. Deharadun: International book distributors; 2006.
12. Nadkarni KM. Indian Materia Medica Vol I. Mumbai: Bombay popular prakashan Pvt. Ltd; 1994.
13. Vuorela I and Aalto M. Palaeobotanical investigations at a Neolithic dwelling site in southern Finland, with special reference to *Trapa natans*. Ann Bot Fenn 1982; 19:81-92.
14. Anonymous. The Ayurvedic Pharmacopoeia of India.1st ed. Part 1, Vol IV. Ministry of Health and Family welfare. New Delhi, India; 2003.
15. Rahman MM, Wahed MI, Biswas MH, Sadik GM, Haque ME. In vitro antibacterial activity of *Trapa bispinosa Roxb*. Science 2001, 1: 214-246.
16. Saltveit ME. Wound induced changes in phenolic metabolism and tissue browning are altered by heat shock. Postharvest Biol Tec 2000; 21: 61.
17. Countryman WD. The history, spread and present distribution of some immigrant aquatic weeds in New England. Hyacinth Control J 1970; 8:50-52.
18. Anonymous. The Wealth of India, A dictionary of Indian Raw Material and Industrial products. Vol X, (CSIR) New Delhi, 2003.
19. Crow GE. and Hellquist CB. Aquatic and wetland plants of northeastern North America. Bull Torrey Bot Club 2000; 6: 352.
20. Karg S. The water chestnut (*Trapa natans L*.) as a foodresource during the 4th to 1st millennia BC at Lake Federsee, Bad Buchau (southernGermany). Environmental archaeology 2006; 1(1):125-130.
21. Burns J, Gardner PT, O'Neil J, Crawford S, Morecroft I, McPhail DB, Lister C, Matthews D, MacLean MR, Lean MEJ, Duthie GG, Crozier A. Relationship among antioxidant acitivity, vasodilatation capacity, and phenolic content of red wines. J Agric Food Chem2000; 48: 220-230.
22. Ciou JY, Chiun CR, Chen J and Chiang PY. Total Phenolics Content and Antioxidant Activity of Extractsfrom DriedWaterCaltrop(TrapaTaiwanensis Nak ai) . Journal of Food and Drug Analysis 2008; 16 (2):41-47.
23. Pavlovic R, Mladenovic J, Radovanovic B , DokovicG A, Zdravkovic J, Zdravkovi M. Phenolic copounds and biological activity of *Capsicum annuum L.* African Journal of Biotechnology 2012 June; 11(45), 10446-10450.
24. KanekoT and Baba N. Protective effect of flavonoids on endothelial cells against linoleic acid hydroperoxide-induced toxocity. Bios Biotechnol Biochem1999; 63: 323-328.
25. Takano A and Kadono Y. Allozyme variations and classification of *Trapa* (Trapaceae) in Japan Aquat Bot 2005; 83: 108-118.
26. Winne WT. Water chestnut: A foreign menace. Bulletin to the Schools 1950 ; 36(7):230-234.
27. Wu MY and Wu J. In-vitro Investigations on Ultrasonic of Water Chestnut. J. Aquat. Plant Management 2007; 45: 76-83.
28. Prajapati ND, Purohit SS, Sharma AK, Kumar T. A hand book of medicial plant .1st ed . Agrobios (india) publishe, jodhpur 2003;519-520.
29. Guo JT, Lee HL, Chiang SH, Lin FI, Chang CY. Antioxidant properties of the extracts from different parts of broccoli in Taiwan. J Food Drug Anal 2001; 9: 96-101.
30. Havsteen B. Flavonoids, a class of natural products of high pharmacological potency. Biochem Pharm 1983; 32: 1141-1148.
31. Wang H, Cao G, Prior RL. Total antioxidant capacity of fruits. J Agric Food Chem1996; 44: 701-705.

32. Madhavi DL, Salunkhe DK. Food Antioxidants. Marcel Dekker Inc, New York,1995.
33. Anjaria J, Parabia M, Dwivedi S. Ethnovetheritage Indian ethnoveterinary medicine an overview.Pathik Enterprise,Ahmedabad 2002.
34. Agarwal T, Shukla DA, Gujrati A, Srivastava N. In vitro analysis of antibacterial activity of *Trapa natans* peel (household waste). IJPRD 2011; 4(suppl 1): 114 – 117.
35. Agrahari AK, Mohd K, Panda SK. Evaluation of analgesic activity of methanolic extract of *Trapa natans l.var. Bispinosa roxb*. Roots. Journal of Current Pharmaceutical Research 2010; 01: 8-11.
36. Saxena HO, Brahmam M. The Flora of Orissa, Vol II. Regional Research Laboratory, Bhubaneswar & Orissa Forest development Corporation Ltd, 1995.
37. Patel SA, Patel NC, Shah MH, Shah VN. Evaluation of anti-inflametory activity of fruit of *Trapa natans.* International Journal of Pharmaceutical Research and Development 201; 3:97-102.
38. Tarnalli A, CheeramkuzhyT. Influence of Clitoriaternateaextracts on memory and central cholinergicactivity in rats. Pharmaceutical biology 2000; 38(suppl1): 51-56.
39. Kar D, Snigdha P, Maharana L, Dash G. Hepatoprotective activity of water chestnut fruit. Indian Journal of Natutal Products 2004; 20: 17-21.
40. Ambikar DB, Vyawahare NS, Harle UN, Khandare RA, Bore VV. Nootropic activity of hydroalcoholic extract of *Trapa bispinosa* . Pharm Communique (Suppl.) 2008; 45:333-334.
41. Makare N, Bodhankar S, Rangari V. Immunomodulato-ry activity of alcoholic extract of *Mangifera indica L* in mice. J Ethnopharmacol 2001; 78: 133-137.
42. Momin A. Role of indigenous medicine in primary health care In: Proceedings of first international se-minar on Unani medicine, New Delhi (India) 1987.
43. Das PK, Bhattacharya S, Pandey JN, Biswas M. Antidiabetic Activity of *Trapa natans* Fruit Peel ExtractAgainst Streptozotocin Induced Diabetic Rats. Global Journal of Pharmacology 2011; 5 (3): 186-190.
44. Singh HD, Singh S, Jindal N, Bawa A, Sexsena DC. Physiochemical characteristic of sensory quality of Singhgoraghra (Tarpa natuns L): an Indian water Chestnut under industrial storage conditions. African journal of Food Science 2010;4(11):693-702.
45. Song MC, Yang HJ, Lee D Y, Ahn EM, Kim DK, Kim JY, Chung DK, Baek N I :Triterpenoids from Trapa pseudoincisa. J. Appl. Biol. Chem. 200750(4); 259-263.