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Recent Production and Marketing Scenarios of Water Chestnut (*Trapa spp.*) in India: A Review

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ABSTRACT

Water chestnut (*Trapa spp.*) is an important annual, floated but rooted aquatic plant of temperate and tropical freshwater wetlands of India. The water chestnut is native to Europe, Asia and Africa and has been widely cultivated for a long time for food in Asia. It thrives best in nutrient-rich water with a pH range of 6.7 to 8.2. The plant *Trapa spp.* has also been recognized as analgesic, anti-inflammatory, anti-diabetic and anti-microbial. The kernels of water chestnut act as a diuretic, aphrodisiac, nutrient, appetizer, astringent, coolant, anti-diarrheal and tonic. It is an excellent source of minerals such as K, Ca and Mg, as well as carbohydrates and protein. In the creation of mixed products, many food products derived from the chestnut kernel and its flour are used. The yield per hectare is approximately 4-4.5 tones of fresh fruit and 1-1.5 tones of dry nuts. As fresh, canned fruit, dry nuts and flour, it has a very promising market in India and internationally. Fresh fruits are extremely delicious. TSS values varied from 7.0 to 9.0 ^{0}B. It is a very lovely and low-cost nutritious food that has the potential to manipulate the food market by making available various water chestnut mix flour items that might play an essential role in addressing malnutrition in India. This study of enumerated areas, production and marketing potential may be of immense value and great interest to researchers and academicians.

Key words: Fruit quality, Marketing, Production, *Trapa* spp. Aquatic plants.

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Water chestnut (*Trapa spp.*) is a well known and premium item of dry nut and atta that's a commodity used in India and abroad as a detoxifying agent. Apart from the dry items, it is generally consumed as fresh fruit in India and commonly known as Singhara and Paniphal. This dry atta is used in various ways such as sweet dishes like kheer, halwa and sweets like ladoo. It is generally used in the treatment of a number of ailments related to reproductive systems and the kidney of the human body. In addition to these medicinal properties, singhara has the cardio-protective properties due to the presence of high value amino acid arginine and high amount of K and Mg content. Due to lower cost of cultivation and as a wild plant, singhara is distributed to most parts of the world and its cultivation is confined to south east Asia only. In India, singhara is grown in the states of Bihar, M.P. West Bengal, Odisha, Assam, U.P, Maharashtra, Punjab and Tamil Nadu. Traditionally, singhara is cultivated in deep water bodies having water depths of 3-5 feet. Natural habitats are rivers, ponds, lakes and damps and are widely cultivated in Asia. It thieves best in soft nutrient rich water with pH range between 6.7 and 8.2 (Bhatial *et al.,* 2012). In the traditional system, due to high depth of water, agronomic management of this crop becomes very difficult and as a result the average productivity of this crop is just 3.5-4.0 t/ha. Water chestnut kernels and its floor are used in the manufacturing of mixed products and production is around 1-1.5 tones dry nut/ha. In these water bodies, transplanting and harvesting are done in June-July and November-December months, respectively. The medicinal use of kernels as diuretic, aphrodisiac, nutrient, appetizer, astringent, coolant, anti-diarrhoeal and tonic. The other uses of the plant as analgesic, anti-inflammatory, anti-diabetic and anti-microbial and stem in the form of juice in eye disorders (Chaudhary *et al.,* 2012). It is a very rich source of minerals like K, Ca and Magnesium and carbohydrates and protein (Salini *et al.,* 2019). In India, it is known as paniphal. In Indian tradition, the fruits are eaten raw or boiled. For making atta or flour the fruits are dried and ground to a flour which is used in many religious rituals and consumed as a Phalahar diet in Indian traditional festival "Navratri" (Chandana *et al.,* 2013). Water chestnut is gluten free, its flour can be used to replace other flours for the production of gluten free items and therefore functional properties of flour have immense value (Chiang and Ciou, 2010). Due to burgeoning population and rapid urbanization natural water bodies are diminishing day by day. The area under this crop is going to be reduced drastically year after year due to presence of other food items and development fishery units. Therefore, estimation of total area, productivity of water chestnut and discussion with the light of recent

advanced technologies for production enhancement are need of the hour to revive the glory of water chestnut crop cultivation. Water chestnut crop is growing year after year in the same pond or shallow ditches which are gradually more contaminated. Further, the national average production is very low and farmers did not get appreciable returns. In this juncture, field based cultivation and management of water chestnut for more production using different high value genotypes are under limelight. Therefore, in the present study we wanted to estimate production, nutritional importance of water chestnuts and their marketing on a national and international level.

Food and nutrition

Enumerated total production of water chestnut fruits is 67,600 tones from 16,900 ha in India (Table 1).

It is a very nutritive food. It is used as food as well as herbal medicine. Fresh nuts are well known for their high water content (80.0%) (Puste, 2004) protein (1.87%) and TSS (7.0-8.0%). According to Adkar *et al.,* (2017) and Alfasane *et al.,* (2011), protein and carbohydrate content of fresh water chestnuts are 4.40% and 22.3%, respectively. Water chestnut is an excellent source of crude fiber (2.13% in green variety and 2.27% in red variety) (Faruk *et al.,* 2012) It is also a fair source of Vitamin B along with Ca, K, Fe and Zn (Singh *et al.,* 2009 and Gopalan *et al.,* 2004). It is also rich in nutrients such as vitamin-A, C, thymine, carbohydrates, amylase, amylo-pectin, beta-amylase, proteins, fats and nicotinic acids, which are beneficial for health. Water chestnuts can be used for diabetes, inflammatory disorders, *etc*. It contains a lot of antioxidants, which flush out the toxins from the body. Fresh fruits are very sweet. TSS ranges from 7.0-9.0°B.

Production

The Bihar Large Red (Spine), the commercial variety of Mithila region, Darbhanga, India, gives a higher yield of 7.0 t/ha. The maximum yield of 12.0 t/ha can be achieved by cultivation of Green Spineless genotype (Jana *et al.,* 2019). In our present study yield is varied from 4.2-12.0 t/ha (Table 2). According to Jana (2016), a well maintained local genotype gives the maximum yield of 2.5-3.5 t/ha. There are vast opportunities to improve production of water chestnut by expanding area, replacing old varieties, adopting advanced agronomic management and marketing practices.

Innovative technology and vast opportunity

It is no more a neglected crop now. Field based cultivation of water chestnut with fresh clean water and improved varieties have a very bright future. Farmers should adapt clean cultivation practices and ensure quality products to the consumer. Following that, the crop will achieve a prestigious place in fresh fruits and dry products in both domestic and foreign markets.

Water chestnuts nowadays are becoming more popular to the following countries and creating a very strong global market.

- North America, South America and the Americas
- Asia Pacific and Japan
- Europe
- Latin America
- Middle East and Africa

Table 1: Approximate area and production of water chestnut in India.

Sl. No.	States	Approx. Area* (ha)	Average Production *@4.5 t/ha	Major Districts of States	References
1.	Bihar	7,000	31500	Darbhanga, Madhubani, Purnia, Katihar, Saharsa, Araria, Patna Bhagalpur, Sitamarhi., *etc*.	News India, 2021
2.	M.P.	6,000	27000	Chhatarpur, Damoh, Panna, Sagar, and Tikamgarh, Niwari, Katni, etc.	IGG, 2020, Nahatkar *et al.,* 2021; Bisen*et al;* 2018.
3.	West Bengal	2,000	9000	Midnapore (East and West), 24 parganas (South and North), Nadia, Howrah, Hooghly, Burdwan, Birbhum and Malda, Murshidabad, *etc*.	E-news/facebook-pages, web-pages (Ghosh, 2019**), Roy Choudhary *et al;* 2018.
4.	Odisha	900	4050	Balasore, Cuttack, Sambalpur, Bhubaneswar, Dhenkanal, *etc*.	Roy Choudhary *et al.,* 2018 and web-pages
5.	U.P.	400	1800	Lucknow, Balia, Kanpur, Kanauj, Jaunpur, Varanasi, *etc*.	Web-pages
6.	Chhattisgarh	300	1350	Raipur and adjoining areas	Annual Report, IGKV and web-pages
7.	Other states	300	1350	Maharashtra, TN, Punjab, Assam, Tripura, *etc*.	Web-pages
Total	All India	16,900*	76050*	More than 45 districts in India	Most of the References

*Approximate total production around 67,600 tones from 16,900 ha in India, **Web-page reference only.

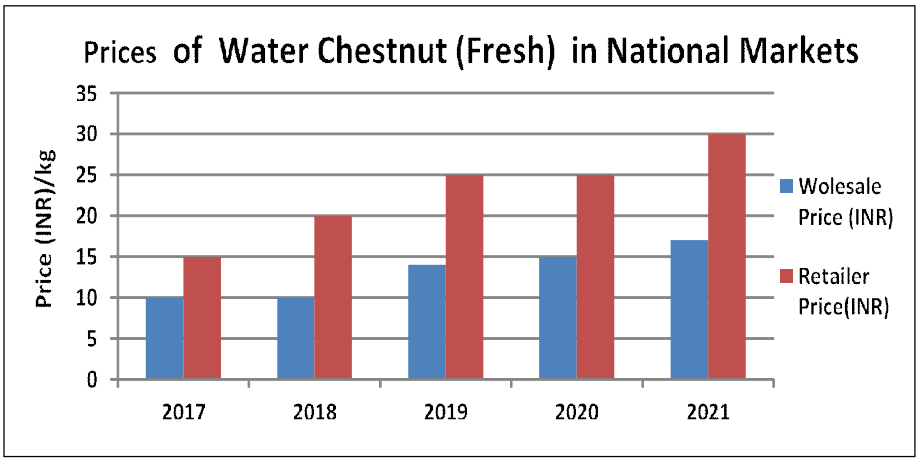

Fig 1: Whole sale and retailer average price/kg of fresh water chestnut from farmers during autumn in Patna and Kolkata.

Table 2: Fruit quality and yield of water chestnut under wetland ecosystem of north Bihar.

Cultivar	Fruit weight (g)	TSS (°B)	Yield (t/ha)
Red spineless*	27.5	9.0	12.0*
Green spineless*	30.7	8.5	10.0*
Red spine	14.5	7.5	4.2
Green spine	17.9	7.0	4.5

*New varieties of water chestnut under evaluation at RCM, Darbhanga, Bihar.

National markets

With the arrival of the autumn, water chestnuts are marketed throughout the Indian sub continent and we are also likely to spot vibrant, green or red hued and flamboyant water chestnuts. Commonly known as paniphal or singhara are packed with excellent health benefits, due to being rich in proximate compositions. Water chestnut is mostly sold in the rural market (Maity and Kundu, 2015). However it is mainly supplied to the main cities of India like, Kolkata, Bombay, New Delhi, Patna, Bhopal, Chennai and Hyderabad (Fig 1). Paniphal is freshly consumed in India and has high demand to Indian people. Public awareness regarding its medicinal properties need to be highlighted.

International markets

India's total export 18795.11 million INR in 2016. Detailed report involves: India exports water chestnut products worth price of 3,901.57 million INR in Jul 2016, 1,833.84 million INR in Jun 2016, 1,963 million INR in Oct 2016, 8,546.17 million INR in Nov 2016, 530.81 million INR in Sep 2016 and 2,045.84 million INR in Aug 2016 in India. Water chestnut is mainly exported to Auckland (NZ), New York, Oakland Houston (USA), Melbourne (Australia), Toronto (Canada), Banjul (Gambia) and Savannah (Georgia). The export items are water chestnut atta, frozen water chestnut and fresh water chestnut fruit. It is also exported to China and Thailand also (Anonymous, 2016). The low cost products supported by multi-culinary utilization of water chestnut fruits and flour are driving the water chestnut market with rising global demand (Anonymous, 2017).

FUTURE PERSPECTIVES

Water chestnut is a low valued nutritious food available in India. India is the homeland for several species of water chestnut. The demand for water chestnuts is increasing day by day. Farmers should sell their product in distant markets for higher profit. Water chestnut mix flour can be developed and provided to consumers for combating malnutrition. Apart from the rural market it has a very nice money earning potential in national and international markets. Now in India water chestnut is cultivated from approximately 16,900 ha in India and approximate total production is 76,050 tones. In future through adoption of high tech farming, the area and production could be increased. As it is a low cost nutritive food the demand of this crop among rural and urban areas may be increased. Water chestnut crop cultivation has a very future prospects with cat fish farming (Ghosh *et al.,* 2016). But poly culture particularly with singhi (*Heteropneustes fossilis*) and magur (*Clarias batrachus*) fishes are important because other fishes destroy this crop by uprooting and feeding on new foliage and flowers. Water chestnut cropping, framing production of even dry nuts and atta are found to be lucrative as it assured better return to the farmers belonging to the wetland ecosystem of India.

CONCLUSION

The current study will provide detailed information on the nutrient constituents, uses, pharmacological activities and economic importance of water chestnut fruit (*Trapa* spp.). Fresh fruit is primarily consumed in Asian countries and has a higher production value. In addition to flour and dried nuts, water chestnuts are commonly used in the market in whole and sliced form in canned items for use in a variety of recipes in the home and in restaurants. In Asia Pacific, North America, Latin America, Europe, Australia, New Zealand, and the Middle East and Africa, the water chestnut is classified as an important food item. Due to traditional culinary uses,

Asia Pacific has the highest share of water chestnut consumption, while North America's consumption share is increasing due to increased multi-culinary acceptance. The water chestnut market is being driven by its low investment cost and multi-culinary utilization as global demand rises. Furthermore, favorable climatic conditions in Asian countries particularly in India have a positive impact on water chestnut cultivation. Farmers should take advantages of its cultivation and distant marketing of fresh as well as processed products for higher profit.

Conflict of interest: None.

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