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A study of knowledge and traditional wisdom of makhana cultivation in Bihar

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Makhana (*Euryale ferox*) is an aquatic crop from the family *Nymphaeace* and is commonly grown in stagnant water bodies like ponds, swamps and ditches with shallow water. *Euryale* is a self-pollinated plant, in which pollination takes place at the early stage of flower development. Bihar is the largest producer of makhana throughout the country with an area of approx 15,000 ha. In spite of several uses and immense market potential in India and abroad, makhana is still cultivated through traditional system, area of which is declining in recent years. Therefore, an attempt was made to understand traditional wisdom of makhana production practices with special reference to its post harvest management. For this purpose, 100 makhana growers were identified from Madhubani district of Bihar which occupies more than 30% of the total area and production. They were personally interviewed with the help of a structured schedule consisting of different components such as, suitable soils in terms of type, quality and its strength, the type, slope and depth of ponds of makhana, the preparation and management of pond for makhana cultivation, seeds with respect to source and quality, fertilizer and disease management, harvesting process of makhana with respect to its the time and process of maturity along with the grading and marketing of makhana. The results indicated that makhana production practices are primarily governed with the traditional knowledge system which the growers obtained through their forefathers.

Keywords: Disease and pest management, *Euryale ferox*, Makhana, Knowledge, Traditional wisdom

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Makhana is considered as a superior dry fruit, as it contains several rich and nutritional ingredients. Edible parts of the seeds contain 12.8% moisture, 9.7% protein, 0.1% fats, 0.5% minerals, 76.9% carbohydrates and 1.4 mg/100 g of iron and traces of carotene[1]. The calorific value of raw and popped seeds of makhana is 362 and 328 K Cal/100 g, respectively. From sustenance point of view, the eminence of makhana protein is very superior to a number of food plant- and animal-based diets[2,3].

In the year 2016, India exported popped makhana worth with US$ 1,049,544 to Australia, Canada, Greece, Singapore, Togo, United Arab Emirates, United Kingdom and United States of America[4]. It is believed that makhana is used in many traditional medicines in China[5]. In spite of this gloomy picture, the cultivation of makhana is highly unorganized and least explored with limited documentation for its cultivation and estimated production. Since, no systematic documents pertaining to the system of makhana production, its processing and marketing are available and as yet no reliable data pertaining to cultivation practices are available hence, considering its importance, uses, market and export potential[4], a need was felt to have systematic study to figure out the grass root reality related with makhana cultivation and its production.

It is well recognized fact that makhana growers are not able to get good return of their produce as commensurate their hard labour and expenditure. At the same time, due to troublesome practice and lack of scientific knowledge they are in the process of quitting their traditional business of makhana production[2,3,5,6]. Hence an attempt was made to generate much needed information related with makhana production technology through its producers directly in order to get the true feedback involved in makhana cultivation.

Methodology

The present study was conducted in Madhubani district of Bihar as this particular district accounts for 30% of total area and production. Further, 100 makhana growers were selected from four blocks of the district viz, Pandaul, Rahika, Kaluahi and Benipatti based on the production. A list of growers was obtained who received training by the institute on various occasions. Further, from the list, 100

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respondents were identified from selected blocks by using proportionate probability principle. The data related with extent of knowledge and makhana production technology was obtained through structured interview. During the data collection, the investigator visited to their respective home or farm wherever they were made available along with interview schedule. The data were systematically arranged and tabulated for meaningful interpretation.

Results and Discussion

In the course of research, the main effort was made to assess the knowledge and traditional wisdom of makhana growers with respect to their different makhana production practices. The makhana cultivation component were described under the different segment such as, suitable soils in terms of type, quality and its strength, the type, slope and depth of ponds of makhana, the preparation and management of pond for makhana cultivation, seeds with respect to source and quality, fertilizer and disease management, harvesting process of makhana with respect to its time and process of maturity along with the grading and marketing of makhana. The results related to these aspects are presented in Tables 1-6.

Table 1 — Knowledge and traditional wisdom of Makhana growers related with soil (N=100)

Component		Knowledge	Traditional wisdom
Soil	Type	73% of respondents believe that black clay soil is essential 18% reported about clay soil while only 9% growers said that silt soil is also favorable for makhana cultivation.	100% makhana growers believe that soil is most essential component in makhana cultivation.
	Quality	100% growers reported that soil quality is important.	83% of respondents ranked soil quality as most essential while, only 17% respondents ranked it as an essential component.
	Strength	57% of residents reported that soil colour and texture are the indication for good soil strength; however, 43% respondents said about soil structure, general appearance or stickiness along with soil colour as the strength of soil.	100% of respondent reported that soil strength/water holding capacity were the most essential element of soil.

Table 2 — Knowledge and traditional wisdom of makhana growers related with pond type, pond preparation and its management (N=100)

Component		Knowledge	Traditional wisdom
Pond	Shape	None of the respondents reported about the actual ideal shape of pond for makhana production.	91% makhana growers said that shape of pond doesn't matter in makhana cultivation, however; 9% respondents reported it as an essential component.
	Slope	74% of respondents reported that 45^{o} slope of pond is essential to avoid soil erosion, while, 26% said that 30^{o} slope is sufficient enough for water holding.	58% of makhana growers reported that slope of pond is most essential element while, 33% reported essential whenever only 9% reported least essential.
	Depth	For plant growth:- 74% of respondents reported that 3 feet standing water is best for plant growth followed by 19% growers who reported 2 feet standing water is enough. Only 7% of respondents told that 4 feet standing water is best suited for makhana production. For Harvesting:- 57% of respondents reported that 6 feet depth of water is best for harvesting while 43% were found 5 to 5.5 feet water depth sufficient for guri (seed) collection.	It was found during the study that ideal depth of pond is most essential component as reported by 78% of respondents whenever 22% found it essential.
Pond preparation and management	Preparation	100% of selected respondents reported that pond preparation (Eradication of weed, cleaning of pond etc.) before seed sowing or in early stage of cultivation are most needed activities for plant growth.	100% respondents reported that pond preparation before seed sowing is most essential for makhana production.
	Management	The eradication of aquatic weed is most important for makhana cultivation. This fact was revealed by 94% of respondents while only 6% of makhana growers were found to control their weed either manually or chemically.	100% respondents reported that eradication of aquatic plants/weeds before and after seed sowing is most essential component.

Table 3 — Knowledge and traditional wisdom of makhana growers related with makhana seed (N=100)

Component		Knowledge	Traditional wisdom
Seed	Source	83% makhana growers often found to use their own collected seed while 17% makhana growers were found to take help of fellow farmers for seed under distress condition.	99% of respondents reported that there was no market for makhana seed while 1% still looking for new variety.
	Quality	100% of respondents reported that quality and healthy seeds could be judged through seed colour, seed size, and weight of seed.	Based on the experience, 97% makhana growers believed that quality seed is most essential component while only 3% of respondents reported that it is an essential component.

Table 4 — Knowledge and traditional wisdom of makhana growers related with fertilizer management (N=100)

Component		Knowledge	Traditional wisdom
Fertilizer management	Type	61% growers do not apply any fertilizer in pond while 39% respondents were found to apply inorganic fertilizer commonly Urea, DAP and trace amount of household organic manures.	It was found during the study that, 98% of respondent reported that fertilizer, method/dose of fertilizer, Proper time of fertilizer application are the most essential component while only 2% of respondents were reported it as least essential.

Table 5 — Knowledge and traditional wisdom of makhana growers related with insect/pest and disease management (N=100)

Component		Knowledge	Traditional wisdom
Disease/Insect & Pest management	Major Disease/Insect and Pests	100% of selected makhana growers reported about different disease problem occurred in their pond. Common disease/insects and pest as reported by them were Aphids, Leaf hopper, Fruit borer, Leaf feeder, Stem borer, Fruit rot, Root rot and Stem rot etc. These diseases were reported by them in local dialect.	100% respondents reported that identification of disease and methods of disease control was found as most essential component for makhana production.
	Disease/Insect and Pest management	71% makhana growers were found to apply Fenvalerate (Trade name Fenval) and lime only while, 29% respondents were found to apply anyone Fenvalerate, Mancozeb, Carbendazim along with lime to control diseases and pests as per availability.	
	Source of information	77% of respondents reported that they got to know the method of disease control by fellow farmers of fisherman cooperative society while 23% of them were found to know through local dealers and friends of their neighboring villages who were involved in makhana production.	

On the basis of findings, the study revealed that black clay soil was most suitable for makhana cultivation and soil quality is the most essential component in makhana production. Makhana grows best at the 2 to 6 feet of water depth; however, shape of pond has no role in makhana production[2,5,7,8]. Pond preparation and management are an important event in makhana production and almost all the growers perform this event. Seeds are the basis of life and so in case of makhana, 83% of the selected growers often found to use their own collected seed as there was no available market for makhana seed in their locality. However some varieties like Swarn Vaidehi[9] and Sabour Makhana-1 have been developed from National Research Centre for Makhana and Bihar Agricultural University, Sabour respectively, but farmers were mostly unaware about them. The 61% of selected respondents did not apply any fertilizer in their Makhana pond[5], but 39% of respondents were found to apply inorganic fertilizer like Urea and DAP. Insects/pests are the major problem as reported by all the respondent, major insects reported by them were aphids, leaf hopper, fruit borer, leaf feeder, steam borer etc[10]. For the remedial measure, 71% of respondent mainly found to use Fenval (Fenvalerate) and about 77% of them reported that they received this information from fellow farmers of fisherman cooperative society. The perusal of findings also revealed that August-September was the ideal period for maturing and harvesting of makhana while

Table 6 — Knowledge and traditional wisdom of makhana growers related with its harvesting and marketing (N=100)

Component		Knowledge	Traditional wisdom
Harvesting	Time of maturity	57% of growers reported that August-September months are the ideal period for maturity and harvesting of makhana while, 43% of them reported the month of September-October was the best period.	100% of respondents were reported that time of maturity was most essential component in makhana cultivation.
	Harvesting time	100% growers reported that they start harvesting of makhana very early period of time in the morning till mid of the day only.	100% respondents said that time of harvesting was most essential component of makhana cultivation.
	Methods of harvest	Almost 100% of respondents were found to adopt the harvest process manually. They considered it as a traditional practice which they learned from their fore fathers.	Almost all the selected respondents considered it as the most essential component of makhana production.
Marketing	Grading	Makhana is graded for marketing in five category according to its size viz., Thurri, Murra, Olwa, Lawa, Lawa Top. It was found during the study that sugar gunny bag of one quintal contains about 8kg of best quality of makhana.	99% respondents reported that marketing is most essential component while only 1% of growers considered that it is an essential aspect in makhana production.
	Place of sell	47% of producers were found to sell their makhana directly in their nearby market whenever, 32% of them were found to sell through local vendors only while 21% growers were found to sell their produce directly to the market along with local vendor.	
	Price	59% of respondents reported that they sold their makhana at the rate of ₹200-250/= per kg while 41% were found to report that they sold it for ₹ 251-300/= per kg.	100% of respondents reported that marketing is the most essential component in makhana production.

harvesting is primarily carried out early in the morning and finished till mid of the day. The harvesting (collection of guri) is often performed manually by all the respondents. As per the report of findings makhana is graded into five categories viz, Thurri, Murra, Olwa, Lawa and Lawa top[2,5,6]. The 47% of the respondents sell their produce directly in the market at a price range of Rs. 200-300/kg but the sell price varies according to the quality and market demand[11].

Conclusion

Overall, it can be concluded from the study that traditional cultivation of makhana is widely adopted in northern region of Bihar. The knowledge related to indigenous makhana production has been passed down from generation to generation and it must be explored for better scientific inclusion. Districts of northern Bihar face severe flooding during monsoon every year and it has numerous traditional water bodies which needed to be utilised effectively. Traditional knowledge and technologies are sustainable and cost effective; however, it has several complications with modern scientific innovations these needed to be addressed in right way. The study was aimed to open an insight into various traditional knowledge and wisdom related with makhana production technology. Introduction of new improved variety, application of nutrients and control of pests was found to be major challenges during the study. The findings from this study will be thus helpful in conserving traditional cultivation of makhana production and at the same time help the farmers to adopt better technologies for improved production and productivity as well as create a new pathway for policy formulation and future research in concerned area.

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Conflict of Interest

The authors of this manuscript hereby declare that there is no conflict of interest in publishing this manuscript.

Authors' contribution

The present work has been conceptualized and designed by A K and A K S. Co-authors B K and S K helped during data collection and reviewing the manuscript. A K S checked and corrected the final

draft. All authors read and approved the final manuscript.

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