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NUTRITIONAL, ETHNOTHERAPUTICS AND SOCIO-ECONOMIC RELEVANCE OF *EURYALE FEROX* SALISB. IN MANIPUR, INDIA

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ABSTRACT:

Euryale ferox Salisbury was often found in the ponds, ditches and lakes of the plains of Manipur. The tender leaves, petioles, fruits and seeds were seasonal cuisines for some of the indigenous recipes. Nutritional parameters like protein, total amino acids, qualitative and quantitative estimation of amino acids, total nitrogen, soluble and insoluble nitrogen, total carbohydrates, total sugar, reducing and non-reducing sugar, starch, fats, ascorbic acids, dry matter, and moisture percentage were estimated. The seeds and rhizomes were used in the treatment of diseases and as stimulants by local healers. The socio-economic relevance of the plant was also studied through household and market survey.

KEY WORD: Thangjing, Demand, Vegetables, Local households and Local healers.

INTRODUCTION:

Euryale ferox, of family Nymphaeaceae locally known as "thangjing" (Photo1 and 2) is commonly found in the lakes, ponds and ditches of the valley of Manipur, India. Mostly, they are grown wild with a fewer cultivation at the household ponds. The plant is also known as "makhana" in bihar and are reported to grow in wild and cultivated to certain extent and used as food by popping like the popcorn and there were no reports of using it as vegetable. The tender leaves, locally known as "khayon" in Manipuri and petioles are served as vegetable in curries, chutney and salad. The fruits are used as cuisines in the preparation of a number of local indigenous recipes viz. "eronba", "singju", "kangsu", "ametpa" etc. The immature fruits locally known as "lolang" are preferred after boiling, while the ripen ones known as "aroba" are consumed preferably in fresh and are sold in the markets. Edible parts of the fruit include

placenta, perisperm and endosperm (photo 3 to 8). This seasonal vegetable was harvested two months after their cultivation by growers during its production season, which is from June-November and has been an indispensable dietary item in the local households. The tender shoot, petiole and fruits are sold in the vegetable markets of the state during the harvesting season. However, the nutritional content and market potential of *E. ferox* needs to be properly evaluated. The seeds and rhizomes of the plant were used in the treatment of a number of diseases by the local healers (maibas).

METHODOLOGY:

Nutritional analyses were performed for the endosperm and perisperm of seeds of *E. ferox*, the main edible parts preferred by the people. For the analyses, fresh as well as dry materials were used depending on the parameter. The analyses were performed and were tabulated (Table 1) following: i) Anthrone method (Dubois, et al. 1951)[1] for the estimation of total soluble sugars (TSS), ii) Nelson's method for estimation of reducing sugars (Nelson, 1994) [2] (RS), iii) non-reducing sugars according to methods of (Malhotra and Sarkar, 1979) [3] and iv) the Anthrone method derived from i) for the estimation of total starch. (TS). Total fat (TF) was determined with the method of Leslie and Fisher, 1971[4], total protein (TP) with (Lowry et al method, 1951)[5], total amino acids (TAA) by Ninhydrin method (Moore and Stein, 1948)[6] qualitative analysis of individual amino acids by TLC method (Stahl, 1969)[7], quantitative estimation of individual amino acids by elution technique, total nitrogen (TN) estimation by micro-Kjeldahl method, soluble and insoluble nitrogen (SN, INT) using the method of Lang (1958)[8]. Ascorbic acid content was determined with the indophenol reduction method (Roe, 1954)[9], total phenol by Foli-Ciocalteu's method (Bray and Thorp, 1954)[10], total phytosterol (TPS) with Libermann-Burchard reaction method (Grunwald, 1970)[11]. Moisture content was determined with the method of (AOAC, 1965)[12]. To understand the nutritional status of *E. Ferox*, the values obtained were compared with the values available for three common fruits used in Indian diet as per Gopalan *et.al.*, 2004 (**Bhogaonkar and Chavan,** 2009)[13]. (Table2). Survey was conducted during 2007-2008 in 300 households of the state on the mode of consumption and the types of recipes of *E. ferox* used in the state, and were tabulated (table 3). Market potential and its socio-economic relevance were studied during 2009-2011 (Table 4 and 5).

RESULTS:

Table1 show the value of nutrients obtained which were converted in gram per 100gm dry weight of the tissue. Table2 shows the comparison of nutritional value of *E. ferox* with the values available for three common fruits used in Indian diet. Table3 shows the type of traditional recipes

of *E. ferox* and their modes of preparations as cited by the respondent households during the survey. The frequencies of utilization of the recipes were expressed based on the number of respondents that cited a particular recipe, out of the 300 households that were interviewed in the 4 plain districts of Manipur as *E. ferox* confines in the valley ponds and not in hills. Only the recipes cited by more than 50% of the respondents are tabulated. From the table, the parts utilized were known to be the young leaves, young petioles, fruits and seeds. Table 4 shows the prices of *E. Ferox* in the markets of plain districts of Manipur. Table 5 shows the profit obtained from *E. Ferox* from the markets of the plain districts of Manipur.

DISCUSSION:

Nutrient value obtained after biochemical analyses were found to be much different and opposite than reported by Alfasane, Md. A. et al, 2008[14]. In the report protein and carbohydrates were high with low fat and moisture contents, whereas, reverse were recorded during the experiment. The protein content in *E. ferox* (0.83 g•100g^{-1} fresh weight), was lower than some of the fruits present in normal Indian diet like ficus, dates, papal figs etc. Twelve different amino acids were earlier reported (histidine, isoleucine, valine, lysine, threonine, leucine, glutamic acid, tyrosine, aspartic, alanine. methionine. and arginine), whereas TLC reveals only 07 different amino acids, out of which 06 were similar with one different amino acids, *viz.* (histidine, isoleucine, valine, lysine, threonine and nor-leusine). The total fat found in endosperm and aril which were respectively 6.7 and 10.20 (mg/100g fresh weight) of *E. ferox*, were much above than earlier reported (i.e. 1.35%) and also from other plants like papal/figs etc. Total carbohydrates ranges from (0.14 - 0.17) g•100g^{-1} fresh wt. was much lower than fruit of Pipal/*Ficus*/B*oswellia*. Ascorbic acids was found to be ranging from 1 to 101(mg/100g fresh wt.) which was much higher than that of papal/ficus/ Boswellia fruits. The moisture content (95g/100g fresh wt.) was higher than the other fruits while fibres were lower in aril. The fibre content of 73% in endosperm of *E. ferox* was much higher than other fruits. Therefore, *E. ferox* have comparatively lower nutrient values but presence of very high ascorbic acids in perisperm (101 mg per 100g fresh wt.), phenols (0.28 per 100g fresh wt. of endosperm) and phytosterol (0.16 per 100g fresh wt. of perisperm) may be responsible for its medicinal properties. The seeds were also reported to be used by local healers in treatment of invalids. The rhizomes are used in the treatment of diuretics, dropsy, jaundice, and gonorrhoea. The rhizomes boiled with a piece of alum were also reported to be effective in the treatment of scabies (Juginder A, 1996)[15]. The plant because of its unique taste in different recipes it is one of the most preferred indigenous seasonal cuisine and the state earn huge income during the cropping season. Farmers sold an amount of (42000±3100) kg day^{-1} to wholesalers at Rs. (25±5)

Kg^{-1} amounting to a total cost price of wholesalers Rs. (1065500±287500) which is the profit of the farmers. Wholesalers in turn sold to retailers at Rs. (30±5) Kg^{-1}, amounting to a total wholesale price of Rs. (1275500 ±303000) day-1, earning a profit of Rs. (210000 ± 15500) day-1. Retailers sold at the rate of Rs. (40 ± 5) Kg^{-1} to sub-retailers, amounting to a total retail price of day^{-1} of Rs. (433000±81500) earning a total profit by the retailers day^{-1} of Rs. (70000 ± 3500). An amount of (2010±145) kg day^{-1} was sold in sub-retail markets at Rs. (45 ± 5) Kg^{-1}, amounting to a total sub-retail price of Rs. (106300 ± 20700) day-1 and earning a total profit of retailers = Rs. 14700 ± 1100 day-1. Therefore, overall profit from *E. ferox* per day during production season in Manipur was Rs.294700 ± 20100 approximately.

CONCLUSION:

Presence of phytosterols in the dietary component helps in lowering plasma, total and LDL cholesterol, and challenges phytosterols - hypocholesterolemic effect[16]. Herbs and herbal polyphenols help in controlling oxidation and prevent the damage by oxidation[17]. Elevated levels of dietary ascorbic acid increase immune responses[18] Phytosterol and ascorbic acid also impart antioxidant, astringent and aphrodisiac property[19]. The presence of the active compounds of family Phenol, phytosterol, flavonoids and alkaloids must be playing a definite role in the treatment of diuretic, dropsy, jaundice and gonorrhoea as is believed by the Meitei community of Manipur. Among other edible parts fruit (nut) was of higher demand and was sold more in the market. Though, young leaves and petioles of *E. ferox* are edible, they are not frequently sold as that of the fruits. The fruits on the other hand were of high demand that they are sold in the market at a much higher price comparing to other vegetables. Yet, the demand could not be met and always surpasses the supply. The decrease in the produce of *E. ferox* have been noticed with the passing time which may be due to i) habitat destruction as result of urbanization, human habitation, ii) overexploitation and ii) lack of conservation activities. The present study highlights the potential of *E. ferox* as a vegetable, medicinal plant and its economic support in the households. Thus, suggest for the intervention of govt. and non-governmental bodies and growers to take up initiative needed for a better production. This study therefore would help in making aware of its importance to the people and helping in its conservation which is needed at present.

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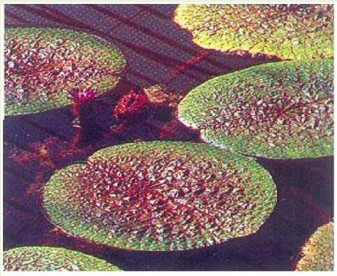

Photo 1: E. ferox (Plant)

Photo 2: E. ferox (young fruit)

Photo 3: E. ferox (mature fruit)

Photo 4: E. ferox (Peeled off fruit wall)

Photo 8: E. ferox (seed, aril, endosperm)

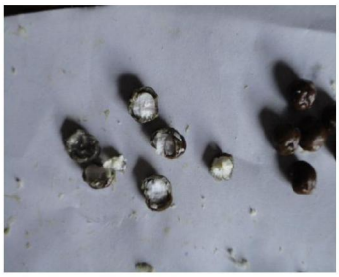

Photo 7: E. ferox (seed showing endosperm)

Photo 6: E. ferox (aril and peeled off seed)

Photo 5: E. ferox (aril covered seed)

Table 1: Nutrients in g per 100g weight of *Euryale ferox* [Mean ± standard deviation in g.100g^{-1} dry wt]

Parts used	Endosperm (E) g/100g dry wt.	Perisperm (P) g/100g dry wt.
Total sugar	14	17*
Reducing Sugar	8.00*	4.00
Non-reducing Sugar	6.00	12.0
Starch	4.0	39*
Total Fat	6.70*	10.2
Total nitrogen	0.07	0.13
Soluble Nitrogen	0.008	0.054*
Insoluble Nitrogen	0.06*	0.09
Total Protein (buffer soluble)	0.02	0.1
Total crude Protein (from total nitrogen)	0.44	0.83
Total free amino acids contents	0.70 mg	10.90 mg
Total Phenol	0.28	0.14
Total Phytosterol	0.07	0.16
Vitamin C	0.001 mg	0.10 mg
Moisture %	27%	95%
Dry matter %	73%	5%
Types and amounts(mg.100g-1) of Amino acids	Lys (0.02), Iso-leu (0.01), Val (0.009), Threo (0.008), Asp acid (0.005), and Hist (0.01)	Lys(0.01), Iso-leu (0.008), val (0.01) Thr (0.02), Nor le (0.005) and Hist (0.006)
*Differences significant at P≥0.05.		

Table 2: Comparison of the nutritional contents of E. *ferox* with other fruits express in g•100g fresh wt.

Phytonutrient	*Ficus carica*	*Phoenix sylvestris*	*Ficus religiosa*	*Boswellia sp*	*E. ferox*
Total Protein (crude)	1.3	1.2	2.5	6.5	0.83 (P) - 0.44 (E)
Total Sugar	7.6	33.8	21.2	11.81	0.14 (E) - 0.17 (P)
Total Fat	0.2	0.4	1.7	1.5	6.7(E) - 10.20 (A)
Ascorbic acids	5.00 mg	3mg	nil	2.52mg	0.001 (E) - 0.10 (A)
Moisture	88.1	59.2	62.4	82.5	27 (E) - 94.90 (A)
Fibre	2.2	3.7	9.9	0.3	73 (E) - (5.10) A
P = Perisperm/aril, E = endosperm					

Table 3: Some of the food recipes of *Euryale ferox* recorded and documented

Name of the Recipes/ utilization	Plant parts used	Frequency (N=300)	Ingredients	Mode of preparation
Thangjing khayon eronba	young leaves	50	pea/rice beans, potato, chilli, fermented fish, coriander	When the plants are at their young stage, and before the fruits are formed; the young leaves are used either roated or roasted and boiled to make the delicacies called khayon eronba. For this preparation roasted or steam cooked chillies, fermented fish, common salt, boiled peas or rice beans and peeled potatoes along with the above roasted or roasted and boiled young leaves are pasted together to make a gravy. Finally with some chopped coriander they are served.
Thanjing soidon eronba	mature fruit, seeds	50	pea/rice beans, chilli, fermented fish	Partially fermented young bamboo shoots called 'soidon' are boiled with peas and/or rice beans and chillis. Then they are pasted together with fermented fish with some common salts, chooped corinder is added and is ready for serving.
Thangjing -pan eronba	mature fruits (seeds, placenta)	300	*Alocasia indica*, fermented fish (ngari) chillies, rice bean (*Vigna umbellate* (Thunb))	Steamed/roasted red or green chillies are made paste with kitchen salt and steamed or roasted fermented fish. Epideris of steam cooked/roasted arum are pilled off and pested together with the above paste. The seeds and placenta of unripped *E.ferox* fruits are steamed/ boiled and is pasted in the above paste. Water is added to the above paste and made gravy and finally chowpped coiander are added and is ready for serving.
Thangjing ametpa	fruits, young leaves and petioles	300	fermented fish (ngaari), chillies	Firstly, roasted/steamed/boiled chilies (red or green) and roasted or steamed fermented fish and salt are made paste. Seeds of fuly rippen *E. ferox* are added and mixed with the paste and is taken as a chilie chutney
Thangjing kangsoy	petiole, young seeds and placenta	250	cowpea(*Vigna unguiculata* (Linn.) Walp), rice bean (*Vigna umbellata* (Thunb)), potato,	A little amount of chopped *Allium hookeri* are fried to a little amount of mustard oil, and freshly peeled rice bean or cowpeas, sliced potatos are then fried together for some time. Water is then added and followed with the addition of fermented fish, dried fish, chillies and common salt. And, when it is cooked,

			fermented fish (ngaari), chillies	chopped coriander leaves are added, and is made ready for the serving.
Thangjing chamthong	seed, placenta, petiole	200	cowpea (*Vigna unguiculata* (Linn.)), rice bean (*Vigna umbellata* (Thunb)), potato, fermented fish (ngaari), chillies, ginger	Chopped *Allium hookeri,* freshly peeled rice bean or cowpeas, sliced potatos are boiled together. After sometime fermented fish, dried fish, chopped red chillies, grounded ginger and common salt are added. And, when it is cooked, chopped coriander leaves are added, and is ready for the serving.
Thangjing kanghou	seeds	100	*Allium odorosum*, potato, cowpea, chili, salt	With higher proportion of finely chopped, Allium odorosum or cowpea and chopped potatoes are fried in mustard oil along with the seeds of fully rippen *E. ferox. Chillies* and salts are added and are eaten as a delicacy.
Thanjing singju	petiole	100	Common salt, pea, gram flour, lotus rhizome, chili, *Houttuynia cordata, Ipoea aquatica, Sesamum indicum, Alocasia cucullata* and fermented fish	All the vegetables including *E. petiole* are sliced and chopped into small pieces, pea and sesamum are roasted and grounded. Fermented fish and red chillies are roasted and pested with salt. To this paste all the vegetables are mixed and are taken raw as salad. The flavour is enhanced with the addition of houttuynia.
Thangjing saag	seed of immature fruits	300	*Allium odorosum*, chili, salt, groundnut, Bori *(* watery paste of *Phaseolus mungo* flour heated and sun dried*)*,	In hot oil groundnut/bori or both are deep fried, taken out and keep aside. Chopped *Allium odorosum* is then fried in oil along with seeds of immature fruits of *E. ferox,* followed by addition of chillies,salt, fried groundnut/bori or both and is stirred till cooked properly and is ready to be served.

Table 4: Market scenario of *Euryale ferox* of the wholesale, retail and sub-retail markets of the Valley (plain) districts of Manipur during the production season (July to Nov. 20009-2011), mean of 20 separate days of observation during the initial and luxuriant growth period.

Name of the market	Category of the Markets	Quantity Sold day-1	Cost price in Rs.Kg-1	Sale price in Rs.Kg-1	Total cost price in Rs.	Total sale Price in Rs.	Total Income (profit) in Rs. day-1
Khwai keithel/ Khwairambad Bazaar	W	42000±3100	25±5	30±5	1065500±287500	1275500 ±303000	210000 ± 15500
	R	10000±500	30±5	35±5	302500±65000	352500 ± 67500	50000 ±2500
Bisnupur Bazaar	R	3000±100	30±5	40±5	90500±18000	120500 ± 19000	30000 ±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Kakching Bazaar	R	3300±100	30±5	40±5	99500±19500	132500 ±20500	33000 ±1000
	SR	200±10	40±5	45±5	8050 ±1400	9050 ±1450	1000 ±50
Thoubal Bazaar	R	3200±100	30±5	40±5	96500±19000	128500 ±20000	32000 ±1000
	SR	200±10	40±5	45±5	8050 ±1400	9050 ±1450	1000 ±50
Nambol Bazaar	R	3200±100	30±5	40±5	96500±19000	128500 ±20000	32000 ±1000
	SR	200±10	40±5	45±5	8050 ±1400	9050 ±1450	1000 ±50
Khurai Bazaar	R	3200±100	30±5	40±5	96500±19000	128500 ±20000	32000 ±1000
	SR	200±10	40±5	45±5	8050 ±1400	9050 ±1450	1000 ±50
Singjamei Keithel	R	3500±100	30±5	40±5	105500 ±20500	140500 ±21500	35000 ± 1000
	SR	300±10	40 ±5	45 ±5	9050 ±1800	13550 ±1950	4500 ±150
Lilong Bazaar	R	2000±100	30±5	40±5	60500 ±13000	80500 ±14000	20000 ±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Nongmeibung Keithel	R	2500±100	30±5	40±5	75500 ±15500	100500 ±16500	25000 ±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Kongba Bazaar	R	2500±100	30±5	40±5	75500 ±15500	100500 ±16500	25000 ±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Pisum Keithel	R	2000±100	30±5	40±5	60500 ±13000	80500 ±14000	20000 ±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Jiri Bazaar	R	1600±100	30±5	40± 5	48500 ±11000	64500±12000	16000±1000
	SR	100±10	40±5	45±5	4050±900	4550 ±950	500 ±50
Sekmai Bazaar	R	2000±100	30±5	40±5	60500 ±13000	80500 ±14000	20000 ±1000
	SR	50±5	40±5	45 ±5	2025 ±450	2275 ±475	250 ±25
Sugnu Bazaar	SR	50±5	40±5	45 ±5	2025 ±450	2275 ±475	250 ±25

Moirang Bazaar	SR	50±5	40±5	45 ±5	2025 ±450	2275 ±475	250 ±25
Keisamthong Keithel	SR	50±5	40±5	45 ±5	2025 ±450	2275 ±475	250 ±25
Kwakeithel Bazaar	SR	50±5	40±5	45 ±5	2025 ±450	2275 ±475	250 ±25
Koirenggei Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Pangei Bazaar	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Lamsang Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Singda Bazaar	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Keisampat Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Tera bazaar	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Lamlai Bazaar	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Saitu gamphrajol Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Arapti Potfam	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Oinam Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Yumnam leikai Potfam	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Leimakhong Bazaar	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25
Serou Keithel	SR	30±5	40±5	45 ±5	1225 ±350	1375 ±375	150 ±25

- Total Income earned by the farmers (plant gatherers/suppliers) from the markets of the plain districts of Manipur on *Euryale ferox* day-1 = Total cost price in the Wholesale market day-1 = Rs. 1052500±222500.

Note: W= wholesalers, R=Retailers, SR=Sub retailers
Interest (profit) per day = Sales Price (S.P.) day-1 - Cost Price C.P.) day-1

1 US$ = Rs. 45

Table 5: Daily Profit of wholesalers, retailers and sub-retailers (vendors) for *Euryale ferox* in the plain districts of Manipur.

Mean ± standard deviation		
wholesalers	**Retailers**	**Sub-retailers/vendors**
Amount sold day^{-1} = 42000±3100 kg	Amount sold day^{-1} = (42000±3100) kg	Amount sold day^{-1} = (2010±145) kg
Cost price of Wholesalers Kg^{-1} =Rs. 25±5	Cost price of retailers Kg-1 = Rs. 30±5	Cost price of sub-retailers Kg^{-1} = Rs. 40±5
Total cost price of wholesalers = Rs. 1065500±287500	Total cost price of the retailers = Rs. 363000 ± 78000	Total cost price of sub retailers/vendors = Rs. 91600 ± 19600
Wholesale price Kg^{-1} = Rs. 30±5	Retail price Kg^{-1} = Rs.(40 ± 5)	Sub-Retailers' price Kg^{-1} = Rs.(45 ± 5)
Total wholesale price day-1 = Rs. 1275500 ±303000	Total sale price of the retailers day^{-1} = Rs. 433000 ±81500	Total sale price of the sub-retailers day-1 = Rs. 106300 ± 20700
Total profit of the wholesalers day^{-1} = Rs. 210000 ± 15500	Total profit of the retailers day-1 = Rs. 70000 ± 3500	Total profit of the sub-retailers day-1 = Rs. 14700 ± 1100
Total income earn on *Euryale ferox* per day in Manipur is Rs.294700 ± 20100 approximately. (By plant farmers, wholesalers, retailers and sub-retailers.)		
1 US$ = Rs. 45		