

Assessing The Awareness and Choices of *Moringa* Incorporated Foods Among People Residing in University Campus in India

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Abstract

Background: Non-communicable diseases constitute the largest part and even growing proportion of the global burden of diseases. Foods incorporated with *Moringa oleifera* leaves can play an important role in combating NCDs along with being nutritionally adequate. This study aims to assess the awareness and to determine the choices for *Moringa* leaves incorporated recipes for NCDs. **Methods:** This cross-sectional study was carried out on 200 people residing in the campus of Banasthali Vidyapith, India. People of age group 18-60 years, men and women both were randomly selected for the study. A pre-tested proforma was used to collect the data. The information includes socio-demographic factors, awareness of the subjects related to *Moringa oleifera* leaves and information related to meal preference for *Moringa* incorporated recipes. Chi-square, weighted average and relative preference was calculated. **Results:** A significant association of household income was observed with inclusion of *Moringa* in their diet, awareness about the use of *Moringa* leaves for therapeutics and NCDs. Weighted average shows the need of high fibre and moderate calorie foods incorporated with *Moringa* leaves. The scores of relative preference reflect the need of *Moringa* recipes in lunch and the cost should be between 20-30 INR. **Conclusion:** People are aware of the therapeutic uses and potential benefits of *Moringa oleifera* but they are not including *Moringa* in their daily diet.

Keywords: Moringa, *Moringa oleifera*, NCDs, obesity.

Introduction

The *Moringa oleifera* Lam, also known as “Drumstick tree”, “Miracle tree”, “Tree of life” is a member of family *Moringaceae* and widely used in folk medicine (Dehghani and Alizadeh 2016; Gopalkrishnan et al. 2016) It is a multipurpose plant and is widely spread over arid countries, tropical areas and from India to Africa. The drumstick tree is utilized as both medicine and food (Al-husnan and Alkahtani 2016; Anwar et al. 2007; Jain et al. 2021). It contains various essential phytochemicals that are present in its different parts including leaves. It provides seven times more vitamin C than oranges, ten times more vitamin A than carrots, seventeen times more calcium than milk, fifteen times more potassium than bananas, nine times more protein than yoghurt and twenty five times more iron than spinach (Rockwood et al. 2013; Gopalakrishnan et al. 2016). Several in vitro and in vivo studies reported that *Moringa* has anti-obesity activity and is associated with decreasing body weight, total cholesterol levels,

triglycerides, LDL, VLDL and increasing HDL (Redha et al. 2021).

The leaves of *Moringa oleifera* (MO) can be considered as functional food for controlling obesity. These leaves promote apoptosis that leads to decrease in adipocyte formation (Balusamy et al. 2019). Overweight and obesity are one of the serious risk factors for several non-communicable diseases such as type 2 diabetes, some cancers, cardiovascular and kidney diseases and other chronic diseases. Global rates of obesity have tripled in the last four decades. These are constantly increasing in pandemic areas thus, representing a global public health issue (Nyberg et al. 2018; Kinnunen et al. 2021). Obesity can also cause mental health disorders, physical inability and social discrimination, can impact the individuals psychologically (Ramezani et al. 2018). Approximately 50% of the adults population could be overweight or obese by 2030, if prevalence of obesity keeps on increasing. It will impose more social, economic and personal cost (Fan et al. 2021). The extract of

MO leaves holds anti-obesity and anti-oxidant property, and it may be utilized as a lipid-lowering drug (Othman et al. 2019).

Scientific literature supports the undeniable nutritional significance of *M.oleifera*. This tree can be referred to as food due to the presence of essential nutrients (Coppin 2008; Oyekale 2017). It helps in prevention of various diseases like cancer, formation of cataract, CVD, age-related macular degeneration and even chronic infectious diseases because of the presence of antioxidants (Lakshminarayan et al. 2005; Bowen and Morbarhan 1995; Kritchevsky 1999). *Moringa* possesses anti-obesity potential, making it an important pharmacological agent. Leaves of *Moringa* can be utilized as tea, eaten raw or as stewed vegetable. It could be stored for several months after drying and will not lose its nutritional value. It can be consumed as a supplement as well. *Moringa* is a very beneficial tree that should be grown in every household to utilize its nutritional value and leaves should be consumed at least once in a week (Oyekale 2017). Medicinal plants research and applications are expanding each day due to therapeutic potential, which can stimulate the progress of novel medicines. *M.oleifera* is still not that popular even though several medicinal and nutritional benefits can be obtained from this miracle tree. *Moringa oleifera* has now grabbed attention of dieticians, health seekers, health professionals because of its potential health benefits. For the health and wellbeing needs, these days developing countries are depending on therapeutic plants, due to which the demand of herbal medicine has been increased. This study was undertaken to assess the awareness of nutritional and therapeutic significance of *M.oleifera* among residents of Banasthali Vidyapith and to determine the demand of *Moringa* incorporated recipes for NCDs including obesity.

Materials and Methods

Study design and participants: This cross-sectional study was conducted on 200 people aged 18-60 years, residing in the campus of Banasthali Vidyapith, Newai, Rajasthan. Of the total 13668 students, 175 wardens, 529 teaching and approximately 942 non-teaching staff; 50 students, 50 wardens, 50 teaching staff and 50

non-teaching staff were selected through random sampling for which random number table was used.

Data collection: A pre-tested structured questionnaire was delivered to the participants by the researcher. The survey was carried out from January 2020 to March 2021. The proforma focused on exploring their day to day needs related to their meal preferences. The proforma was developed to elicit general information from participants including socio-demographic profile, awareness regarding *Moringa oleifera* leaves and their needs based on meal preferences. Both English and Hindi languages were used for the data collection as per the convenience of the subjects. The inclusion criteria were adults belonging to the age group of 18-60 years willing to take part in the study and present on the day of the survey. On the other hand, adults with any problem (physical or mental) that could cause inconvenience in the study and the adults on a specific diet were excluded from the study.

Socio-demographic factors: This included information on age, gender, level of education, marital status, social class, monthly household income, family type, employment status, work shifts, food habits and physical activity level. Total physical activity score was given based on the following formula (Dumitru 1997):

Index = Intensity x Duration x Frequency

As per physical activity index, score between 81-100 was categorized as excellent physical activity level (PAL), score between 61-80 was categorized as very good PAL, score between 41-60 was categorized as good PAL, score between 20-40 was categorized as weak PAL and score less than 20 was categorized as very weak PAL.

Awareness regarding *Moringa oleifera*: Awareness of the subjects related to *Moringa oleifera* leaves was observed by the means of including questions related to frequent inclusion of drumstick in their diet, knowledge about the leaves and flowers of drumsticks being edible, previous ever consumption of drumstick leaves in the diet, knowledge about drumstick leaves being the richest source of vitamin, mineral and their therapeutic potential. Individuals were also asked to rank the disorders for which they need therapeutic food.

Meal preferences: The information related to meal preferences of the subjects was attained by knowing their willingness towards trying out the recipes made from the incorporation of drumstick leaves, the meals in which they want drumstick leaves to be incorporated, the average per serving cost and where the availability of such recipes they think should be.

The needs assessment was conducted to identify the unmet needs of the subjects and to know additional nutrition-related qualities (moderate in calories, high in fibre, low in carbohydrate, sugar free, cholesterol free, easy to prepare, low cost, exotic and longer shelf-life) they wanted to have in the drumstick leaves incorporated recipes and food categories (meal replacement, starters, snacks, appetizers, beverages, desserts, ready to eat and main course) in which they want fresh and dry drumstick leaves to be incorporated. The subjects were asked to choose most appropriate option from no need, low need, moderate need and high need for each of the parameters.

Ethical consideration: Ethical consideration given by ICMR (2017) based on Helsinki Declaration were adhered to. Participants were asked to sign the informed consent form before filling the information in proforma. Since the study restricted to needs assessment survey only and no invasive data collection was to be done, a formal clearance from ethical committee of the institution was not required.

Data analysis: The collected data were analyzed using Statistical Package for Social Sciences (SPSS) version 20.0. Frequency, percentage, mean and standard deviation were calculated. The weighted average was calculated to assess the level of need. Chi-square test was conducted to test the null hypothesis and association ($p < 0.05$) between socio-demographic characteristics and the unmet needs of individuals. Relative preference was also calculated.

Results and Discussion

The mean age (years) of participants was 34.4 ± 8.6 and majority (77%) of participants were women. The lowest age of the participants was 23 years and the highest was 55 years. A total of 13% participants had completed

doctorate degree, 62.5 % had completed post-graduation, 8.5% had completed graduation, 6.5% had completed their senior secondary, 7% of them had studied till class 10 and 2.5% of them never went to school. Among the 150 working participants, 74.7% participants were working full time, 9.3% were working part time and there were 16% participants who were on long leave. The results of the study showed that 66.5% were married followed by 31.5% being unmarried, 2% were widowed and none of them were separated or divorced. The type of family was predominantly nuclear family (49.5%), followed by 35% participants living alone owing to their job 14.5% were from joint family and 1% were from extended family. With respect to social class (self-perceived) 90.5% study subjects belonged to middle class, 9.5% to upper class and none of them was from lower class. Out of the 200 participants, 71% of participants had reported their monthly household income $\geq 36,997$ INR per month whereas, 17% reported between 18,498-36,996, 6% reported between 13,874-18,497, 1% reported between 9,249-13,873, 2% reported between 5547-9248, 2% reported between 1866-5546 and 1% had reported less than 1865 INR. Majority (86%) participants had lacto-vegetarian food habits, 6% were lacto-ovo-vegetarian, 8% were following non-vegetarian food habits. An excellent physical activity level was a characteristic for 3% and very good physical activity for 9% participants. On the other hand, 10% of the participants were good at physical activity, 20% were sedentary and 58% were having very weak physical activity level.

Majority of the subjects (81%) did not include MO in their diet frequently. About three fourth of the subjects (72%) knew that the MO leaves are edible. Nearly two thirds of the subjects (64.5%) knew that the flowers are edible as well. More than half of the (55.5%) subjects previously used or had consumed foods made from MO leaves. More than half of these subjects (73%) consumed them in the fresh form and 27% of them consumed it in dried form. Fifty-seven percent subjects were aware that there were *Moringa* tree near their residential/office area. Most of the subjects (87%) were aware that MO leaves have therapeutic use. About two third of the subjects (66%) knew that MO leaves are primarily used

for controlling non-communicable diseases. With respect to vitamin content of MO leaves, 45.1% answered that MO leaves are richest source of vitamin C, 27.1%, 17.5% and 10.5% selected vitamin B, vitamin A and vitamin D respectively as an option to this question. With respect to mineral content of MO leaves, 35.5% answered that MO leaves are richest source of iron, 27.5%, 15.5%, 11.0%, 10.5% answered calcium, potassium, magnesium, and zinc respectively. Mean and frequency distribution of subjects based on the ranks given to the disorders for which they need therapeutic foods are depicted in tables 1 and 2.

Majority of the subjects (87%) were willing to try out recipes made by the incorporation of MO leaves. About 75.8% participants wanted the MO leaves to be included in fresh form. Greater number of subjects preferred inclusion of MO leaves in foods for lunch followed by breakfast. Evening snacks, dinner or munching foods were less preferred meals to have MO added foods. Minimal cost of the MO leaves incorporated recipes being 'in between 20-30 rupees' was preferred by most of the subjects. Table 3 illustrates the distribution of the participants on their choice of meals, cost and availability for food incorporated with *Moringa* leaves. The availability of these recipes was preferred to be at home by more than half of the subjects. Majority of the subjects (68%) chose homemade (cheaper) healthier option for incorporation of MO leaves over the market available branded (costlier) one. Table 4 depicts the relative preference of different cost of recipe, type of meal, availability of recipe, source of vitamin and source of mineral. Results of the relative preference show that, participants prefer that recipes incorporated with MO leaves should be available at home, cost should be between 20-30 INR and should be ones that can be eaten in lunch.

A significant association ($p=0.01$) was observed between the education level and the inclusion of MO leaves in the diet. A significant association ($p=0.00$) was also observed between the household income and the inclusion of MO leaves in the diet. A significant association ($p=0.006$) was observed between the household income and awareness among participants on therapeutic uses of MO leaves. The household

income ($p=0.00$) and food habits ($p=0.03$) were significantly associated with the participants' awareness on the prevention of non-communicable diseases by MO leaves

The household income ($p=0.01$) and food habits ($p=0.00$) were significantly associated with meal preference. A significant association ($p=0.00$) was observed between family type and participants preference that where they would like such recipes to be available. A significant association ($p=0.01$) was observed between social class and their preference for branded or homemade MO leaves powder. Distribution of participants and weighted average based on need of additional qualities and preference for adding fresh and dry *Moringa* leaves in different food categories are depicted in table 5. On the basis of weighted average analysis, the highest need was of high fiber foods (2.63) followed by moderate in calories (2.51). The highest need (2.02) was observed for incorporation of drumstick leaves was of starters both in the fresh and dried forms of MO.

The homogeneity lied in the fact that all of them were residing in the same region and similar kind of lifestyle. It was diverse with respect to gender, age, educational status, household income. A study conducted by Kassali et al. 2020 showed that majority of participants were females. A total of 58% subjects were married. Majority of subjects were educated enough to understand the benefits of *Moringa oleifera* uses and consumption. A study was conducted on the female university students, with respect to physical activity index, 34.7% subjects were sedentary, 33.4% subjects had poor physical level, 13.3% were active, 11.4% had good physical condition and 6.9% had very good physical level (Radu et al. 2015). Physical activity levels in South Asians was very low. Low physical activity can contribute to increased risk of coronary heart disease (Williams et al. 2010). The prevalence of insufficient physical activity was high among the adult participants (Moniruzzaman et al, 2017). South Asian adults exhibited lower level of physical activity when compared to American population whereas when compared to Canadian population, they exhibited higher levels of physical activity (Mahmood et al. 2020).

The results of the current study showed that majority of participants were aware of the benefits, edibility and therapeutic uses of MO but they were not including MO in their diet. The reason of not including MO in diet was the bitterness of MO leaves. Participants did not know how to incorporate MO in different recipes. The results are in line with that of Oyekale (2017) where a total of 80.5% of subjects were aware that *Moringa* can be consumed as leaves. Likewise, a study conducted by Milla et al. 2021 reported that all parts of the drumstick tree are edible still it is not completely safe as the roots and bark of the tree possess some compounds. The leaves of the tree were identified as the safest part of the tree for human consumption.

A study by Neergheen-Bhujun et al. (2020) showed that majority of participants (99.0%) knew about *Moringa oleifera* leaves. Maximum number of participants (88.9%) consumed MO leaves. The cheap price and availability of *Moringa* leaves were also a determinant for consuming MO leaves. The foremost reason of not consuming these leaves was its taste. Similar results was observed in the current study. Our results demonstrated that majority of participants do not include drumstick leaves frequently in their diet but they had eaten foods made of drumstick leaves.

Since MO is easily accessible and have therapeutic properties, majority of subjects in the present study were open to trying out recipes made of MO leaves and they want MO leaves to be included in fresh form. Similar results were reported by Farinola et al, 2014, 59% of the respondents were females and there were 85.3% respondents who were aware that *M.oleifera* can significantly contribute to the health and well-being of the people. Nearly 80.7% respondents had consumed *Moringa*. Out of these, 80.7% claimed that they prefer MO in fresh form.

Majority of subjects prefer MO leaves product in lunch, cost 20-30 INR and it should be homemade. Due to increased risk on NCDs, high in fibre and moderate in calories, these two additional qualities were preferred by participants. Majority of participants have high need of starters with respect to fresh and dried MO leaves incorporated food. Paleti et al (2022)

reported that high quality, nutrition benefits, taste, package, color, availability and cost of MO products, these are some factors that influence the individual's preference towards MO products. MO could be used in the development of low calorie foods as food products made by incorporating MO were low in fat and high in fibre (Milla et al. 2021).

Socio-demographic factors including age, ethnic group, employment status and awareness levels were having a significant association with consumption of *Moringa* leaves. No significant association was found between factors like gender, marital status, household monthly income level, family type, district, educational level, vegetarianism and *Moringa* leaves consumption (Neergheen-Bhujun et al. 2020). Present study is in contrast to this study as current study showed the significant association between education, household income with the inclusion of drumstick leaves in diet.

Conclusion

During the course of field survey of this findings, the awareness level of *Moringa oleifera* was observed high in overall study as participants were aware of the potential benefits of MO leaves. They were aware that the leaves of MO are edible and have therapeutic uses. Participants are aware that leaves are useful in preventing and controlling NCDs including obesity. The needs assessment survey reflects that people need qualities like high fibre and moderate calories in food that are suitable in obesity and other NCDs. Participants prefer MO incorporated food to be available at home and their cost should be between 20-30 INR per serving. More focus should be given to incorporate *Moringa oleifera* leaves in the diet and to improve the taste by reducing the bitterness.

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Table 1 Frequency distribution of participants based on the ranks given to the disorders for which they need therapeutic food

Disorder/Ranks	1	2	3	4	5	6	7	8	9	10
	N(%)									
Type II Diabetes Mellitus	100 (50)	26 (13)	16 (8)	-	-	44 (22)	-	-	14 (7)	-
Obesity	40 (20)	62 (31)	14 (7)	-	28 (14)	-	36 (18)	20 (10)	-	-
Hypertension	20 (10)	32 (16)	58 (29)	10 (5)	18 (9)	34 (17)	-	-	20 (10)	8 (4)
Hypercholesterolemia	-	22 (11)	-	-	88 (44)	-	38 (19)	-	32 (16)	20 (10)
Arthritis	20 (10)	40 (20)	40 (20)	66 (33)	-	20 (10)	-	14 (7)	-	-
Asthma	-	-	12 (6)	40 (20)	-	-	-	46 (23)	20 (10)	82 (41)

Dyslipidemia	-	-	20 (10)	44 (22)	-	20 (10)	36 (18)	30 (15)	30 (15)	20 (10)
Osteoporosis	-	-	16 (8)	-	58 (29)	2 (1)	36 (18)	30 (15)	30 (15)	30 (15)
CVD's	-	18 (9)	-	20 (10)	8 (4)	36 (18)	34 (17)	40 (20)	40 (20)	-
Preventive Health	20 (10)	-	24 (12)	20 (10)	-	44 (22)	20 (10)	18 (9)	14 (7)	40 (20)

Table 2 Mean of the ranks given to the disorders for which the participant feel the need of therapeutic food

Disorders	Mean±SD	Rank (on the basis of mean)
Type II Diabetes Mellitus	2.9±2.5	1
Obesity	3.7±2.5	3
Hypertension	4.2±2.5	4
Hypercholesterolemia	6.1±2.3	5
Arthritis	3.5±1.8	2
Asthma	7.8±2.5	10
Dyslipidemia	6.5±2.2	7
Osteoporosis	6.9±2.1	9
CVD's	6.6±2.0	8
Preventive Health	6.2±2.8	6

Table 3 Distribution of the participants on their choice of meals, cost and availability for food incorporated with *Moringa* leaves

Statements/questions	Meals	N(%)
If you are offered a drumstick leaves containing food, in which meal would you prefer?	Breakfast	56 (28.0)
	Lunch	94 (47.0)
	Evening snacks	14 (7.0)
	Dinner	20 (10.0)
	Believe in munching	16 (8.0)
	Cost (INR)	N(%)
How much do you think the cost (in rupees) of a drumstick leaves incorporated recipe (per serving) should be?	Less than 5	12 (6.0)
	5 - 10	32 (16.0)
	10 - 20	36 (18.0)
	20 - 30	56 (28.0)
	30 - 40	28 (14.0)
	40 - 50	20 (10.0)
	More than 50	16 (8.0)
	Place	N(%)
	Home	140 (70.0)

Where would you like such recipes to be available?	Canteen/cafe/restaurant	40 (20.0)
	Roadside stall	4 (2.0)
	Lunch box	14 (7.0)
	Others	2 (1.0)

Table 4 Relative preference of different cost of recipe, type of meal, availability of recipe, source of vitamin and source of mineral

Vitamins	Relative preference scores
A	0.60
B	0.78
C	1.32
D	0.30
Minerals	
Calcium	0.81
Iron	1.17
Potassium	0.42
Magnesium	0.30
Zinc	0.30
Meals	
Breakfast	0.84
Lunch	1.31
Evening snacks	0.21
Dinner	0.30
Believe in munching	0.24
Cost (INR)	
Less than 5	0.18
5 - 10	0.48
10 - 20	0.54
20 - 30	0.84
30 - 40	0.42
40 - 50	0.30
More than 50	0.24
Place	
Home	2.10
Canteen/cafe's/restaurants	0.60
Roadside stalls	0.06
Lunch box	0.21
Others	0.03

Table 5 Distribution of participants and weighted average based on need of additional qualities and preference for adding fresh and dry *Moringa* leaves in different food categories

	No Need	Low need	Moderate need	High need	Weighted average
N (%)					
Needs based on additional qualities					
Moderate in calories	2 (1.0)	28 (14.0)	36 (18.0)	134 (67.0)	2.51
High in fibre	4 (2.0)	12 (6.0)	38 (19.0)	146 (73.0)	2.63
Low in carbohydrate	90 (45.0)	38 (19.0)	34 (17.0)	38 (19.0)	1.10
Sugar free	14 (7.0)	34 (17.0)	24 (12.0)	128 (64.0)	2.33
Cholesterol free	9 (18.0)	10 (5.0)	30 (15.0)	142 (71.0)	2.48
Easy to prepare	8 (4.0)	14 (7.0)	118 (59.0)	60 (30.0)	2.15
Low cost	16 (8.0)	14 (7.0)	112 (56.0)	58 (29.0)	2.06
Exotic	106 (53.0)	18 (9.0)	42 (21.0)	34 (17.0)	1.02
Longer shelf life	92 (46.0)	18 (9.0)	16 (8.0)	74 (37.0)	1.36
Needs based on the food categories in which they want to add fresh <i>Moringa</i> leaves					
Meal replacement	36 (18.0)	30 (15.0)	116 (58.0)	18 (9.0)	1.58
Starters	24 (12.0)	40 (20.0)	44 (22.0)	92 (46.0)	2.02
Snacks	44 (22.0)	40 (20.0)	28 (14.0)	88 (44.0)	1.80
Appetizers	22 (11.0)	48 (24.0)	116 (58.0)	14 (7.0)	1.61
Beverages	126 (63.0)	26 (13.0)	44 (22.0)	4 (2.0)	0.63
Desserts	140 (70.0)	28 (14.0)	22 (11.0)	10 (5.0)	0.51
Ready to eat	10 (5.0)	20 (10.0)	142 (71.0)	28 (14.0)	1.94
Main course	24 (12.0)	24 (12.0)	122 (61.0)	30 (15.0)	1.79
Needs based on the food categories in which they want to add dry <i>Moringa</i> leaves					
Meal replacement	40 (20.0)	38 (19.0)	104 (52.0)	18 (9.0)	1.50
Starters	24 (12.0)	44 (22.0)	36 (18.0)	96 (48.0)	2.02
Snacks	40 (20.0)	22 (11.0)	36 (18.0)	102 (51.0)	2.00
Appetizers	30 (15.0)	40 (20.0)	110 (55.0)	20 (10.0)	1.60
Beverages	118 (59.0)	40 (20.0)	22 (11.0)	20 (10.0)	0.72
Desserts	128 (64.0)	30 (15.0)	30 (15.0)	12 (6.0)	0.63
Ready to eat	18 (9.0)	20 (10.0)	128 (64.0)	34 (17.0)	1.89
Main course	32 (16.0)	34 (17.0)	80 (40.0)	14 (7.0)	1.18