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RESEARCH ARTICLE

MORINGA OLEIFERA AND ITS RECENT PRACTICE IN FOOD INDUSTRIES – A ‘SUPER FOOD PRODUCT’ TO BEAT MALNUTRITION: A REVIEW

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Abstract

Moringa oleifera commonly known as drumstick tree or horseradish tree is widely distributed in India and other subtropical and tropical parts of the world. Besides its conventional culinary uses, Moringa has profound contribution to herbal medicine, agricultural and livestock development, water purification, bio-fuel production and so on. Being one of the richest sources of different macro and micro nutrients, antioxidants and other bioactive compounds, this miracle tree recently has gained popularity in food processing industry with the aim to curb the sprawling malnutrition. In some countries like African countries, either fresh or dried Moringa leaf, seed and flower powder are being used to fortify different foods. Improved texture, sensory and nutritional quality and extended shelf life of the target products have been making this tree important for food industry. So the aim of this review is to reveal the present application of Moringa as food fortificant in food processing industries in different countries, factors those restrain its further applicability and also to focus on the need of future research in this regard.

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Introduction:-

Moringa oleifera is a plant, belonging to the Moringaceae family of Brassicales order. This plant grows wildly in tropical and subtropical parts of the world and also cultivated in some other regions due to its economical value. It is fast-growing plant that achieves a height of approximately 10-12 meter, with or without much care. It grows mostly in loamy or sandy soil with a pH of 6.3-7 i.e. in neutral to slightly acidic pH and also it can resist drought or heavy rainfall. 25⁰C-30⁰C temperature and 250-3000mm rainfall are the most preferred climatic factors for its growth. Fortunately, India is one of largest countries producing Moringa; other countries of south Asia or south-east Asia, South America and Africa also contribute to its production. This tree is commonly known as drumstick tree, horseradish tree, ben oil or benzolive tree^[1-2].

Every part of the plant is edible to the different communities and is being used in culinary purposes especially in Indian cookery. Its high nutritive value, wide range of phytochemicals has made it a ‘miracle tree’ with a power to alleviate different diseases along with malnutrition. Nutrient rich leaves, flowers or immature pods are now processed to fortify different food products or for making food supplements. So this study is aimed to reveal the recent usage of Moringa in food fortification in various food processing industries and the problems or factors those

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restrict its extensive use and also to emphasize on the need of further intense research on *Moringa oleifera* so that it can be used as a weapon to weed out malnutrition and other deficiency diseases in future.

Position of *Moringa oleifera* in Plant Kingdom:

M.oleifera, which is a member of plantae kingdom, is a vascular, flowering and seed plant. It belongs to the Moringaceae family of Brassicales order and the genus is Moringa. It contains nearly 13 species across the world ranging from tiny little herbs to large trees. *Moringa oleifera* is the species that is common in India and some others are *M.drouhardii*, *M.pygmaea*, *M.ruspoliana* and so on ^[1,2].

Different parts of the Plant and their uses ^[1]:-

DIFFERENT PARTS	THEIR USES
Whole tree	Wood, fencing, fuel, food, medicine
Wood	Fencing, fuel
Young root	Medicinal value
Bark	Medicinal value
Leaves	Culinary uses, food, supplement preparation for both human and animal, medicinal value
Flowers	Food, medicine, supplement food preparation
Seeds	Culinary uses, eaten as raw immature seed, seed oil preparation, seeds as coagulant in water treatment, bio-fuel production

Nutritional Composition:

Moringa is a plant which is completely a 'storehouse' of all the macro and micro nutrients, necessary for growth and development.

Key nutrients present in *Moringa oleifera* are:

Carbohydrate - starch, monosaccharide and functional oligosaccharide.

Protein – almost all the essential and non essential amino acids required for growth. Its leaves and pods are enriched with amino acids arginine, histidine, lysine, leucine, isoleucine, valine, phenylalanine, tryptophan, methionine and threonine. Among these leucine is in highest amount in leaves and pods (9.3gm and 6.5 gm/16gm Nitrogen accordingly). Moringa is a rich source of sulphur containing amino acids.

Lipid – seed oil is rich in n₃, n₆ PUFA, oleic acid (MUFA), saturated fatty acid like palmitic acid.

Vitamin – beta carotene (pro vitamin of vitamin A), vitamin C, B- complex vitamin (thiamine, riboflavin, niacin, folic acid) are present in large amount.

Minerals – calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), iron (Fe), zinc (Zn), copper (Cu).

This tree is not only a good source of nutrients but also they are highly bio available. It was reported that administration of *M.oleifera* leaf powder produced better result than synthetic vitamin A as it had increased liver storage of vitamin A without raising plasma retinol level. According to National Institute of Nutrition (NIN) only 10 gm of fresh moringa leaves can meet the daily need of vitamin A of preschoolers. It supplies calcium which is six times of calcium obtained from milk, provides more iron than animal livers and spinach, more fibre than oats and can meet up the daily requirement of zinc ^[1-6].

But the nutrient content in different parts of the tree varies depending on the species, weather, soil quality and other environmental factors ^[2-5].

Nutritional composition of different parts of the tree ^[2, 4, 6]:-

Nutrients	Fresh leaves	Leaf powder	Pods	Seeds
Calorie (kcal)	92	205	26
Protein (gm)	6.7	27	2.5	35
Fat (gm)	1.7	2.3	0.1	38

Carbohydrate (gm)	13.4	38.2	3.7	8.6
Dietary fibre (gm)	0.9	19	4.8	2.8
Vitamin C (mg)	220	17.3	120	4.5
Ca (mg)	440	2003	30	45
Mg (mg)	42	368	24	635
K (mg)	259	1324	259
Fe (mg)	0.85	28.2	5.3

Phytochemicals Present:

Every part of the tree is also loaded with wealthy phytochemicals which include glucosinolate, iso-thiocyanates, flavonoids like quercetin, kaempferol, alkaloids, phenolic acids, carotenoids, tocopherol, anthocyanin, glycosides and so on ^[1-2,7].

Pharmacological Uses:

Moringa oleifera is a medicinal plant whose uses are well documented in traditional herbal medicine. Root, bark, foliage, flowers, pods or seeds all contribute to pharmacological properties of the tree. These include anti hyperglycaemic, anti diabetic, anti tumour, anti cancer, anti hypertensive, antispasmodic, anti inflammatory, anti pyretic, anti microbial, hepato protective, galactogogue, abortifacient, antioxidant, hypocholesterolemic, neuro protective activities ^[8-9].

Moringa oleifera and Malnutrition:

Undernutrition and deficiency diseases are the serious public health problems among the third world countries. Poor accessibility to nutrient rich foods, low purchasing capacity, infection, ignorance are the major causes that thrust the 'at risk' groups towards malnutrition. So a cheap and easily available food product which will be accepted by the mass is of highly needed in those countries and *Moringa* sp. is one of the best options for this. Developing and as well as the developed countries have now started to explore different species of *Moringa* and researches have been going on utilisation of this 'miracle tree' in different ways to tackle malnutrition and deficiency diseases. And the most common ways are: ^[10].

1. Incorporation of moringa products to different diet to enrich them nutritionally.
2. Using moringa as a fortificant in food fortification.
3. Use of moringa products as food supplements.

Recent Research:

Since the last few decades moringa has been studied extensively to use it in food fortification. Dried leaves of moringa have been processed to produce herbal tea which retains better nutritional and sensory qualities than other herbal tea ^[11]. A study in Greece showed that herbal tea prepared from *M.oleifera* dried leaves had a great antioxidant activity due to flavonoles and total phenol contents ^[12]. Chandra et al. (2019) showed effectiveness of noodles prepared by substituting the wheat flour with moringa leaf to enhance breast milk production in lactating women. The product was thought to be effective to prevent malnutrition in children as well ^[13]. Adi et al. (2019) formulated crispy noodles through supplementing moringa leaf puree and ensured a high nutrient and antioxidant enriched food product with acceptable organoleptic properties and could be a great nutritious snacks for school goers ^[14]. Ganga and Karthiayani et al. (2019) in Chennai, India, found that noodles are low in carbohydrate and can be a good source of dietary fibre and other MUFA or PUFA, when supplemented with *M.oleifera* flower and also it is a low glycaemia index food ^[15]. Another study revealed that dried leaf powder of moringa incorporated into dough for making cookies has improved nutritional quality and addition of dried leaf up to 10% was acceptable in respect of its sensory evaluation. Content of nutrients like phosphorus, zinc or iron (P, Zn, Fe) increased significantly in composite breads produced from flour mixture of wheat and yam fortified with *Moringa* but no significant changes was found regarding the sensory evaluation between breads made from whole wheat or composite flour. Bread made from wheat flour, fortified with debittered seed flour of *Moringa* (10%), produced bread with better retention of macro and micro elements and the cookies produced from such dough was acceptable with characteristic nutty flavour ^[16,17]. *Moringa* seed oil, which is a rich source of unsaturated fatty acids mainly oleic acid has been experimented to fortify cheese and showed better shelf life, colour, texture and appearance of the product than the others (sunflower or olive oil) ^[18]. Hassan et al. (2016) utilised *Moringa oleifera* leaf powder in soft white cheese production and showed treatment of cheese with dried leaf powder of *M.oleifera* at 1%, exhibited excellent result in terms of total nitrogen, amino acids content and quality and also regarding organoleptic properties. Bisanz et al. (2015) made a study on rural Tanzanian pregnant women and revealed that functional yogurt supplemented with

M.oleifera, improved micronutrient deficiency of them and it was safe even in their pregnancies ^[19, 20]. Weaning food for infants prepared from blending 70% fermented maize, 10% millets and 20% *M.oleifera* flower powder was good in sensory characteristics and also was nutritionally rich and beneficial for babies to curb malnutrition ^[21]. Chicken meat nuggets fortified with *M.oleifera* flower powder showed improved antioxidant activity, dietary fibre content and reduced peroxidation of lipid during storage without modifying its sensory attributes ^[22].

In a district of Tanzania, an intervention study by supplementing moringa leaf powder on anaemic children was done and they were followed up for 6 months and the result indicated improvement in haemoglobin concentration and similar result was found in a study in Ghana, Africa ^[23, 24]. A pilot study which was a randomized controlled trial regarding the efficacy of moringa leaf powder to improve blood retinal level in Ghana, Africa, inferred that moringa incorporated to complementary food could be beneficial to prevent VAD (vitamin A Deficiency) in target groups ^[25]. The northern part of Cameroon, where Moringa is commonly eaten by the local people, Moringa sauce (1 gm of Moringa/100gm sauce) acidulated by lime juice showed acceptability by local consumers and increased Fe and Zn bioavailability was observed as well ^[26].

Factors to be considered before the application of Moringa in Food industry:

Now it is widely accepted that Moringa is a ‘super food’ and has super power to defend malnutrition and other health issues. Nutritionally enriched plant parts of Moringa could definitely be a powerful food fortificant, as it improves nutritional quality, stability of the product and also makes the products acceptable (when Moringa is used up to a certain limit). But still there are certain problems in its applicability, which includes:

1. Anti nutritional factor: tannin, saponin, glucosinolate, cyanogenic glycosides, iso-thio cyanate, digestive enzyme inhibitors.
2. Contradiction with different medicines like medication of thyroid.
3. Microbiological risks due to pathogenic bacteria: *Clostridium perfringens*, *salmonella sp.*
4. Safety issues regarding its toxicity (causes genotoxicity at a dose of 3000mg/kg body wt. in experimental rats) ^[27, 28, 29].

Possible way out:

Processing of plant products with the application of heat before supplementation, like blanching, boiling or other heat treatment can kill pathogenic microbes and reduce anti nutritional factors as well. Additionally, several food processing methods like germination, fermentation are effective to reduce amylase or trypsin inhibitors; fermentation has more effect over germination; extrusion technology can also be used. Furthermore various methods of drying like oven drying, sun drying, air drying and freeze drying are advantageous to remove anti nutritional factors among which freeze drying has been proved as best. Pre-treatment with alkali has been done in some studies and was effective too ^[29-33].

Though some researchers showed toxic effect of Moringa in different studies, but till date no harmful effect of Moringa or its products have been reported on both animals and human health ^[27]. Some studies mentioned that powder of moringa leaf at a dose of 14gm/day was safe when administered to undernourished groups in both long and short term studies ^[34]. And it is also safe for infants, pregnant, lactating mothers or other vulnerable groups up to a certain limit ^[28, 29].

Conclusion:-

Thus the above review work tried to explore the beneficial use of the miracle tree in food industry and especially its use as food fortificant. Our country along with other developing countries sustain from different nutritional deficiency diseases, *Moringa oleifera* which is widely distributed, could be a weapon to prevent such diseases. During the last few years, ample research has been done on its applicability as food fortificant in various food products, but still there is paucity of data, especially in our country. So more works to be done on different parts of the plant and their incorporation into different inexpensive products which are consumed largely by the mass and which will not modify its sensory qualities and only then this tree can be used as a ‘potential tool’ to defeat malnutrition.

Reference:-

1. Saini, r. K., sivanesan, i. And keum. Y. S., phytochemicals of moringa oleifera: a review of their nutritional, thera

2. Peutic and industrial significance. 3 biotech., 2016, 6, 203.
3. Saini, r. K., sivanesan, i. And keum. Y. S., phytochemicals of moringa oleifera: a review of their nutritional, therapeutic and industrial significance. 3 biotech., 2016, 6, 203.2. Gopalakrishnan, I., doriya, a. K. And kumar, d. S. Moringa oleifera: a review on nutritive importance and its medicinal application. Food science and human wellness., 2016, 5, 49-56.
4. Ii. 3. Daba, m., miracle tree: a review on multi-purposes of moringa oleifera and its implication for climate change mitigation. Journal of earth science & climatic change., 2016, 7, 366.
5. Iii. 4. Abbas, r., elsharbasy, f. S. And fadlemlula, a. A., nutritional values of moringa oleifera, total protein, amino acid, vitamins, minerals, carbohydrates, total fat and crude fiber, under the semi-arid conditions of sudan. Journal of microbial & biochemical technology., 2018, 10, 56-58.
6. Iv. 5. Yameogo, c., bengaly, m.d., savadogo, a. And nikiema, p. A., determination of chemical composition and nutritional values of moringa oleifera leaves. Pakistan journal of nutrition., 2011, 10, 264-268.
7. V. 6. Fugile, I. J., the moringa tree: a local solution to malnutrition church world service in senegal. (2005). [Http://www.moringanews.org/documents/nutrition.pdf](http://www.moringanews.org/documents/nutrition.pdf) (<http://www.moringanews.org/documents/nutrition.pdf>. Accessed: 1st march, 2020.
8. Vi. 7. Rani, n. Z. A., husain, k. And kumolosasi, e., moringa genus: a review of phytochemistry and pharmacology. Front. Pharmacol., 2018, 9, 108.
9. Vii. 8. Paidesetty, s. K., mishra, d., ghosh, g. And panda, c.s., medicinal uses and pharmacological properties of moringa oleifera. International journal of phytomedicine, 2010, 2, 210-216.
10. Viii. 9. toma, a., and deyno, s., phytochemistry and pharmacological activities of moringa oleifera. International journal of pharmacognosy, 2014, 1, 222-231.
11. Ix. 10. Mushtaq, b. S., hussain, m. B., omer, r., toor, h. A., waheed, m., shariati, m. A., sargey, p. And heydari, m., moringa oleifera in malnutrition: a comprehensive review. Curr drug discov technol, 2019. Doi: 10.2174/1570163816666191105162722.
12. X. 11. Wickramasinghe, y. W. H., wickramasinghe, l. And wijesekara, l., effect of steam blanching, dehydration temperature & time, on the sensory and nutritional properties of a herbal tea developed from moringa oleifera leaves. Int j food science, 2020, 2020.
13. Xi. 12. Lalas, s., nutritional characterization of leaves and herbal tea of moringa oleifera cultivated in greece. Journal of herbs, spices & medicinal plants, 2017, 23.
14. Xii. 13. Chandra, s., dwivedi, p., arti., anjana. And shinde, l.p., significance of moringa noodles for increasing breast milk. International research journal of food and nutrition, 2019, 1.
15. Xiii. 14. Adi, a. C., rachman, q. And arimbi, a. N., the acceptance and nutritional value of crispy noodles supplemented with moringa oleifera as a functional snack for children in a food insecure area. Prev nutr food sci, 2019, 24, 387-392.
16. Xiv. 15. Ganga, m. U., karthiayiani, a., vasanthi, g. And baskaran, d., study on development of fiber-enriched noodles using moringa leaves (moringa olifera). Asian journal of dairy and food research, 2019, 38, 145-149.
17. Xv. 16. Dachana, k. B., rajiv, j., indrani, d. And prakash, j., effect of driedmoringa(moringa oleifera lam)leaves on rheological, microstructural,nutritional, textural and organolepticcharacteristics of cookies. Journal of food quality, 2010, 33, 660- 677.
18. Xvi. 17. Ogunsina, b. S., radha, c. And, indrani, d., quality characteristics of bread and cookies enriched with debittered moringa oleifera seed flour. Int j food sci nutr, 2011, 62, 185-94.
19. Xvii. 18. Hassan, f.a.m., enab, a. K., abd, m. A. M., gawad, el., rabou, n. S. A., sayed, h. S. And abdalla, a., production of healthy functional soft white cheese using moringa oleifera oil. Pakistan journal of biological sciences, 2018, 21, 394-400.
20. Xviii. 19. Hassan, f.a.m., enab, a. K., abd, m. A. M., gawad, el., bayoumi, h. M. And yousef, y. B., utilization of moringa oleifera leaves powder in production of soft white cheese. International journal of dairy science, 2017, 12, 137- 142.
21. Xix. 20. Bisanz, j.e., enos, m.k., praygod, g., seney, s., macklaim, j.m., chilton, s., willner, d., knight, r., fusch, c., fusch, g., gloor, g.b., burton, j.p. And reid, g., microbiota at multiple body sites during pregnancy in a rural tanzanian population and effects of moringa-supplemented probiotic yogurt. Appl environ microbiol, 2015, 81, 4965-75.
22. Xx. 21. Arise, a. K., arise, r. O., sanusi, m. O., esan, o. T. And oyeyinka, s. A., effect of moringa oleifera flower fortification on the nutritional quality and sensory properties of weaning food. Croat. J. Food sci. Technol, 2014, 6, 65-71.

23. Xxi.22. Madane, p., das, a., pateiro, m., nanda, p., bandyopadhyay, s., jagtap, p., barba, f., shewalkar, a., maity, b., drumstick (*moringa oleifera*) flower as an antioxidant dietary fibre in chicken meat nuggets. *Foods*, 2019, 8, 307. 10.3390/foods8080307.
24. Xxii. 23. Angela, e. S., susan, f. R., ndekya, m. O., stella, p. K. And julius, j. M., effect of moringa oleifera leaf powder supplementation on reducing anemia in children below two years in kisarawe district, tanzania. *Food science and nutrition*, 2019, 7, 2584- 94.
25. Xxiii. 24. Boateng, l., quarpong, w., ohemeng, a., asante, m. And steiner-asiedu, m., effect of complementary foods fortified with moringa oleifera leaf powder on hemoglobin concentration and growth of infants in the eastern region of ghana. *Food sci nutr*, 2018, 7, 302-311.
26. Xxiv. 25. Boateng, l., ashley, i., ohemeng, a., asante, m., & steiner, m., improving blood retinol concentrations with complementary foods fortified with moringa oleifera leaf powder - a pilot study. *Yale j biol med*, 2018, 91, 83-94.
27. Xxv. 26. Mawouma, s., ponka, r. And mbofung, c. M., acceptability and solubility of iron and zinc contents of modified moringa oleifera sauces consumed in the far-north region of cameroon. *Food sci nutr*, 2016, 5, 344-348.
28. Xxvi. 27. Thulani, t., bhekumthetho, n., ntakadzeni, e. M., trevor, t. N., hloniphani, p. M., mbulisi, s. And ashwell, r. N. Scribbling the cat: a case of the "miracle" plant, moringa oleifera. *Plants (basel)*, 2019, 8, 510.
29. Xxvii. 28. Asare, g. A., gyan, b., bugyei, k., adjei, s., mahama, r., addo, p., otu-nyarko, l., wiredu, e.k., nyarko, a. Toxicity potentials of the nutraceutical moringa oleifera at supra-supplementation levels. *J ethnopharmacol*, 2012, 139, 265-72.
30. Xxviii. 29. Walia, k., Kapoor, a. And farber, j. M. Qualitative microbiological risk assessment of moringa oleifera leaf powder to be used to treat undernutrition in infants and children in cambodia and india: a review. *J food prot*. 2019, 82, 513-521.
31. Xxix. 30. Ijarotimi, o.s., adeoti, o. A. And ariyo, o., comparative study on nutrient composition, phytochemical, and functional characteristics of raw, germinated, and fermented moringa oleifera seed flour. *Food sci nutr*. 2013, 1, 452-63.
32. Forsido, s.f., duguma, h.t., lema, t.b., sturm, b. And hensel, o. Nutritional and sensory quality of composite extruded complementary food. *Food sci nutr*. 2019, 7, 882-889.
33. Ademiluyi, a. O., aladeselu, o. H., oboh, g. And boligon, a. A., drying alters the phenolic constituents, antioxidant properties, α -amylase, and α -glucosidase inhibitory properties of moringa (*moringa oleifera*) leaf. *Food sci nutr*, 2018, 6, 2123-2133.
34. Devisetti, r., sreerama, y. N. And bhattacharya, s., processing effects on bioactive components and functional properties of moringa leaves: development of a snack and quality evaluation. *J food sci technol*, 2016, 53, 649-57.
35. Barichella, m., pezzoli, g. And faierman, s.a., nutritional characterisation of zambian moringa oleifera: acceptability and safety of short-term daily supplementation in a group of malnourished girls. *Int j food sci nutr*, 2019, 70, 107-115.