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Review

On the Efficacy of Moringa Oleifera as Anticancer Treatment: A Literature Survey

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Abstract

Medicinal plants are important elements of indigenous medical system that have persisted in developing countries. Many of the botanical chemo-preventions currently used as potent anticancer agents. However, some important anticancer agents are still extracted from plants because they cannot be synthesized chemically on a commercial scale due to their complex structures that often contain several chiral centers. The aim of this study was to test different extracts from the Moringa oleifera leaves. Previous studies have shown potentially antioxidant, antitumor promoter, anticlastogen and anticarcinogen activities both in vitro and in vivo. Emerging evidence indicates that efficacy of Moringa oleifera in cancer treatment deserves re-examination. This paper is a short literature survey of research in recent years.

Keywords: moringa oleifera, antioxidant, anticancer

Introduction

Moringa Oleifera (MO), aplant from the family Moringa ceaisa major cropin Asia and Africa (they can be found in Himalaya Mountain, and have been used for thousand years in India etc.). MO has been studied for its health properties, attributed to the numerous bioactive components, including vitamins, phenolic acids, flavonoids, isothiocyanates, tannins and saponins, which are present in significant amounts in various components of the plant. Moringa Oleifera leaves are the most widely studied and they have shown to be beneficial in several chronic conditions, including hypercholesterolemia, high blood pressure, diabetes, insulin resistance, non-alcoholic liver disease, cancer and overall inflammation. Mean while, it is known that cancers are the leading causes of morbidity and mortality worldwide, with approximately 14 million new cases and 8.2 million cancer related deaths. The number of new cases is expected to rise by about 70% over the next 2 decades. Among men, the 5 most common sites of cancer diagnosed were lung, prostate, colorectum, stomach, and liver cancer. Among women the 5 most common sites diagnosed were breast, colorectum, lung, cervix, and stomach cancer [7].This paper is a short literature survey of research on MO efficacy as anticancer treatment in recent years.

Identification

[4] "Moringa is a small, fast-growing, drought deciduous tree or shrub that reaches 12m in height at maturity. It has a wide-open, typically umbrella- shaped crown, straight trunk (10-30 cm thick) and a corky, whitish bark. The plant (depending on climate) has leaflets 1-2 cm in diameter and 1.5-2.5 cm in length its leaves are impair pinnate ,rachis 3 to 6 cm long with 2 to 6 pairs of pinnules. Each pinnule has 3 to 5 obovate leaflets that are 1 to 2 cm long. The terminal leaflet is often slightly larger. Its leaflets are quite pale when young, but become richer in color with maturity. Cream-colored flowers emerge in sweet-smelling panicles during periods of drought or water stress when the tree loses its leaves. The pods are triangular in cross-section-30 to 50 cm long and legume-like in appearance. The oily seeds are black and winged. The tree produces a tuberous taproot, which explains its tolerance to drought conditions."

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Occurrence throughout the world

[5] "This species is a fast growing soft wood tree that can reach 12 m in height and is indigenous to the Himalayan foothills (northern India Pakistan and Nepal) [2,3]. Its multiple uses and potential attracted the attention of farmers and researchers in past historical eras. Ayurvedic traditional medicine says that Moringa oleifera can prevent 300 diseases and its leaves have been exploited both for preventive and curative purposes [4]. Moreover, a study in the Virudhunagar district of Tamil Nadu India reports Moringa among the species utilized by traditional Siddha healers [5]. Ancient Egyptians used Moringa oleifera oil for its cosmetic value and skin preparation [6]. even if the species never became popular among Greeks and Romans, they were aware of its medical properties [7]. Moringa oleifera has been grown and consumed in its original areas until recently (the 1990s) when a few researchers started to study its potential use in clarifying water treatments, while only later were its nutritional and medical properties "discovered" and the species was spread throughout almost all tropical countries. In 2001, the first international conference on Moringa oleifera was held in Tanzania and since then the number of congresses and studies increased disseminating the information about the incredible properties of Moringa oleifera. Now this species has been dubbed "miracle tree", or "natural gift", or mother's best friend." [4] "Moringa trees though native in the sub-Himalayan tracts, it is widely cultivated in Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines. According to Muluvi et al (1999), the Moringa tree wide natural spread in the world and introduced to Africa from India where it used as a health supplement and it was originally an ornamental tree in the Sudan, planted during British rule in the alleys along the Nile, public parks, and the gardens of foreigners. It seems likely that the Arab women of Sudan discovered this remarkable clarifier tree. "

Phytochemistry

As Moringa oleifera leaves are most used part of the plant, we review articles concerning Phytochemistry and pharmacological properties of leaves. Several bioactive compounds were recognized in the leaves of Moringa oleifera. They are grouped as vitamins, carotenoids, polyphenol, phenolic acids, flavonoids, alkaloids, glucosinolates, isothiocyanates, tannins, saponins and oxalates and phytates. The amounts of different bioactive compounds found in Moringa oleifera leaves and reported in literature are summarized in following tables.

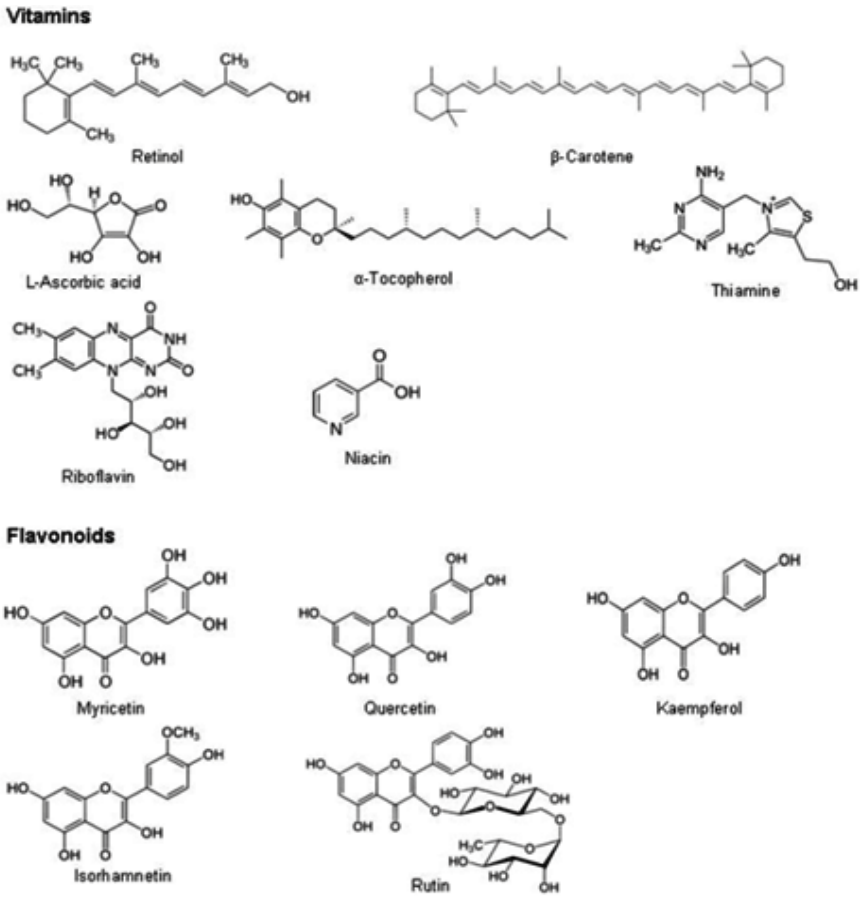

Figure 1: SChemical structures of bioactive compounds in MO. After Leone et al. [5]

Table 1. Vitamins content in *Moringa oleifera* leaves.

Bioactive Compound	Leaves	Value Found in Literature	Value Express as Dry Weight	Drying Method	Extractive Method	Analytical Method	Country	Reference
Vitamins								
Vitamin A	fresh	11,300 IU	45,200 IU		N/A	N/A	India	[14]
	fresh	23,000 IU	92,000 IU [a]		N/A	N/A	Brazil	[52]
Vitamin B1–Thiamine	fresh	0.06 mg/100 g	0.24 mg/100 g		N/A	N/A	India	[14]
	fresh	0.21 mg/100 g	0.84 mg/100 g		N/A	N/A	N/A	[53]
	fresh	0.6 mg/100 g	2.58 mg/100 g		N/A	Microbiological method	India	[54]
	dried	2.64 mg/100 g	2.85 mg/100 g	N/A	N/A	N/A	N/A	[53]
Vitamin B2–Riboflavin	fresh	0.05 mg/100 g	0.20 mg/100 g		N/A	N/A	India	[14]
	fresh	0.05 mg/100 g	0.20 mg/100 g		N/A	N/A	N/A	[53]
	fresh	0.17 mg/100 g	0.726 mg/100 g		N/A	Microbiological method	India	[54]
	dried	20.5 mg/100 g	22.16 mg/100 g	N/A	N/A	N/A	N/A	[53]
Vitamin B3–Niacin	fresh	0.8 mg/100 g	3.20 mg/100 g		N/A	N/A	India	[14]
	fresh	0.8 mg/100 g	3.20 mg/100 g		N/A	N/A	N/A	[53]
	fresh	0.82 mg/100 g	3.5 mg/100 g		N/A	Microbiological method	India	[54]
	dried	8.2 mg/100 g	8.86 mg/100 g	N/A	N/A	N/A	N/A	[53]
Vitamin C–Ascorbic acid	fresh	220 mg/100 g	880 mg/100 g		N/A	N/A	India	[14]
	dried	17.3 mg/100 g	18.7 mg/100 g	N/A	N/A	N/A	N/A	[53]
	dried	92 mg/100 g 140 mg/100 g 56 mg/100 g	92 mg/100 g 140 mg/100 g 56 mg/100 g	Sun-drying for 4 days Shadow-drying for 6 days Oven-drying at 60 °C for 1 h	N/A	AOAC 2004	India	[55]
	dried	38.8 mg/100 g [b]	38.8 mg/100 g [b]	Air-drying	Metaphosphoric acid	Indophenol titration	Pakistan	[56]
	freeze-dried	271 mg/100 g	271 mg/100 g	Freeze-drying	Deionized water	Colorimetric method	Florida, USA	[57]
	freeze-dried	920 mg/100 g 840 mg/100 g 680 mg/100 g	920 mg/100 g 840 mg/100 g 680 mg/100 g	Freeze-drying	6% metaphosphoric acid	Titration against 2,6-dichlorophenolindophenol	Nicaragua India Niger	[58]
Vitamin E–Tocopherol	fresh	9.0 mg/100 g	16.21 mg/100 g		N-hexane + ethyl acetate + BHT	Reverse-phase HPLC	Malaysia	[59]
	dried	113 mg/100 g	122.16 mg/100 g	N/A	N/A	N/A	N/A	[53]
					Microscale saponification and			

Table 1: Vitamin content in MO leaves. After Leone et al. [5]

Table 2. Carotenoids content in *Moringa oleifera* leaves.

Bioactive Compound	Leaves	Value Found in Literature	Value Express as Dry Weight	Drying Method	Extractive Method	Analytical Method	Country	Reference
Carotenoids								
β-carotene	fresh	6.63 mg/100 g	33.48 mg/100 g		Acetone–n-hexane	HPLC	Taiwan	[62]
	fresh	6.8 mg/100 g	27.22 mg/100 g		N/A	N/A	N/A	[53]
	dried	36 mg/100 g 39.6 mg/100 g 37.8 mg/100 g	36 mg/100 g 39.6 mg/100 g 37.8 mg/100 g	Sun-drying for 4 days Shadow-drying for 6 days Oven-drying at 60 °C for 1 h	N/A	AOAC 2004	India	[55]
	dried	16.3 mg/100 g	17.62 mg/100 g	N/A	N/A	N/A	N/A	[53]
	dried	18.5 mg/100 g	20.44 mg/100 g	Air-dried under shade	N/A	HPLC	South Africa	[61]
	freeze-dried	66 mg/100 g	66 mg/100 g	Freeze-drying	Acetone	HPLC	Florida, USA	[57]
Lutein	fresh	6.94 mg/100 g	35.05 mg/100 g		Acetone–n-hexane	HPLC	Taiwan	[62]
	freeze-dried	102 mg/100 g	102 mg/100 g	Freeze-drying	Acetone	HPLC	Florida, USA	[57]

Abbreviation: N/A = Not available.

Table 2: Carotenoids content of MO leaves. After Leone et al. [5]

Table 3. Polyphenols content in *Moringa oleifera* leaves.

Bioactive Compound	Leaves	Value Found in Literature	Value Express as Dry Weight	Drying Method	Extractive Method	Analytical Method	Country	Reference
Polyphenols								
	dried	4581 mgGAE/100 g [a] 3602 mgGAE/100 g [b]	4581 mgGAE/100 g [a] 3602 mgGAE/100 g [b]	Shade-drying	Water Soxhlet extraction for 18–20 h	Folin-Ciocalteau	India	[63]
	dried	3290 mgGAE/100 g	3290 mgGAE/100 g	N/A	50% MeOH	Folin-Ciocalteau	India	[64]
	dried	2090 mgGAE/100 g	2090 mgGAE/100 g	N/A	50% MeOH, 100% MeOH and water	Folin-Ciocalteau	India	[65]
	dried	10,504 mgGAE/100 g	10,504 mgGAE/100 g	N/A	Water at 80 °C for 2 h	Folin-Ciocalteau	India	[66]
	dried	10,616 mgGAE/100 g [c]	10,616 mgGAE/100 g [c]	Air-drying	80% MeOH	Folin-Ciocalteau	Pakistan	[56]
	dried	10,300 mgGAE/100 g 12,200 mgGAE/100 g 9720 mgGAE/100 g 11,600 mgGAE/100 g	10,300 mgGAE/100 g 12,200 mgGAE/100 g 9720 mgGAE/100 g 11,600 mgGAE/100 g	Air-drying	100% MeOH 80% MeOH 100% EtOH 80% EtOH Extraction by shaker	Folin-Ciocalteau	Pakistan	[67]
Total phenols	dried	9630 mgGAE/100 g 10,700 mgGAE/100 g 6160 mgGAE/100 g 8210 mgGAE/100 g	9630 mgGAE/100 g 10,700 mgGAE/100 g 6160 mgGAE/100 g 8210 mgGAE/100 g	Air-drying	100% MeOH 80% MeOH 100% EtOH 80% EtOH Extraction by reflux	Folin-Ciocalteau	Pakistan	[67]
	dried	2070 mg TAE/100 g	2070 mg TAE/100 g	Air-drying	Acetone/Water (7:3)	Folin-Ciocalteau	India	[68]
	dried	1600 mgTEA/100 g [d] 3400 mgTEA/100 g [e]	1600 mgTEA/100 g [d] 3400 mgTEA/100 g [e]	Air-drying	80% EtOH	Folin-Ciocalteau	Nicaragua	[69]
	dried	5350 mgCAE/100 g 2930 mgCAE/100 g 3710 mgCAE/100 g 3280 mgCAE/100 g 4550 mgCAE/100 g 4460 mgCAE/100 g	5350 mgCAE/100 g 2930 mgCAE/100 g 3710 mgCAE/100 g 3280 mgCAE/100 g 4550 mgCAE/100 g 4460 mgCAE/100 g	Oven-drying at 60 °C for 24 h	Maceration with 70% EtOH Maceration with 50% EtOH Percolation with 70% EtOH Percolation with 50% EtOH Soxhlet extraction with 70% EtOH Soxhlet extraction with 50% EtOH	Folin-Ciocalteau	Thailand	[70]

Table 3: Polyphenols content of MO leaves. After Leone et al. [5]

Anticancer Effects

MO has been studied for its chemo preventive properties and has been shown to inhibit the growth of several human cancer cells. The capacity of MO leaves to protect organisms and cells from oxidative DNA damage, associated with cancer and degenerative diseases, has been reported in several studies. Khalafalla et al. found that the extract of MO leaves inhibited the viability of acute myeloid leukemia, acute lymphoblastic leukemia and hepatocellular carcinoma cells. Several bioactive compounds, including 4-(α-L-rhamnosyloxy) benzyl isothiocyanate, niazimicin and β-sitosterol-3-O-β-D-glucopyranoside present in MO, may be responsible for its anti-cancer properties. MO leaf extract has also been proven to be efficient in pancreatic and breast cancer cells. In pancreatic cells, MO was shown to contain the growth of pancreatic cancer cells, by inhibiting NF-kB signaling as well as increasing the efficacy of chemotherapy, by enhancing the effect of the drug in these cells. In breast cancer cells, the antiproliferative effects of MO were also demonstrated. A recent study by Abd-Rabou et al. evaluated the effects of various extracts from Moringa Oleifera, including leaves and roots, and preparations of nanocomposites of these compounds against HepG, breast MCF7 and colorectal HCT116/Caco2 cells. All these preparations were effective on their cytotoxic impact, as measured by apoptosis. Several animal studies have also confirmed the efficacy of Moringa Oleifera leaves in preventing cancer in rats with hepatic carcinomas induced by diethyl nitrosamine and in suppressing azoxymethane-induced colon carcinogenesis in mice. Alist of some bioactive components present in MO leaves, their postulated actions in the animal model used, their protection against a specific disease and the corresponding reference are presented in Table 1."

Moreover, according to Abdull Razis et al., MO leaves also have anti-inflammatory, antitumor and anticancer effects [2].

Table 4: Bioactive Components in *Moringa Oleifera* and their Positive Effects on Chronic Disease.

Compounds	Postulated Function	Model Used	Disease Protection	References
Flavonoids: Quercitin	Hypolipidemic and anti-diabetic properties	Zucker rat	Diabetes	[36]
	Lower hyperlipidemia	Rabbits	Atherosclerosis	[37,38]
	Decrease expression of DGAT	Guinea Pigs	NAFLD	[80]
	Inhibition of cholesterol esterase and α-glucosidase	In vitro study	Cardiovascular disease and Diabetes	[60]
	Inhibits activation of NF-kB	High fat fed Mice	Cardiovascular disease	[74]
Chlorogenic Acid	Glucose lowering effect	Diabetic rats	Diabetes	[45]
	Cholesterol lowering in plasma and liver	Zucker rat	Cardiovascular disease	[46]
	Decrease expression of CD68, SERBP1c	Guinea pigs	NAFLD	[87]
	Anti-obesity properties	High-fat induced obesity rats	Obesity	[49]
	Inhibit enzymes linked to T2D		Diabetes	[90]
Alkaloids	Cardioprotection	Cardiotoxic-induced rats	Cardiovascular disease	[49]
Tannins	Anti-inflammatory	Rats	Cardiovascular/Cancer	[54]
Isothiocyanates	Decreased expression of inflammatory markers	RAW Macrophages	Cardiovascular disease	[76]
	Reduction in insulin resistance	Mice	Diabetes	[88]
	Inhibition of NF-kB signaling	Cancer breast cells	Cancer	[99]
B-Sitosterol	Decrease cholesterol absorption	High-fat fed rats	Cardiovascular disease	[18]

Abbreviations used: CD68: cluster of differentiation 68; DGAT: diacyl glycerol transferase; NF-kB: nuclear factor-kB; SRBP1c: sterol regulatory binding protein 1c; T2D: type 2 diabetes; NAFLD: non-alcoholic fatty liver disease.

Table 4: Bioactive components in MO. (After Vergara-Jimenez et al. [1])

Hypotheses on MO chemo preventive effects

[3] "We speculated that the chemo preventive effect of bMO arose from fatty acids present in MO which might modulate cell proliferation and/or apoptosis and anti-inflammation which plays an important role in colon carcinogenesis. It has been reported that human colon tumor growth is promoted by oleic acid through mechanisms that comprise an increase in fatty acid oxidation and disturbance of membrane enzymes [4]. In contrast, olive oil, an important source of omega-9 oleic fatty acid, may prevent against the development of colorectal cancer through its influence on secondary bile acid patterns in the colon. Another hypothesis for chemo preventive effect of MO pods may be due to the modulation of detoxification enzyme. It has been shown that MO pods extract has the potential for modulating phase I and II enzymes such as cytochrome b5, cytochrome P450, catalase, glutathioneperoxidase, reductase and S-transferase in mice [5]. Moreover, the diet containing bMO showed potentially anti-clastogenic activity against both direct and indirect-acting clastogens in male ICR mice [6]. In the present study, a potent colon carcinogen, AOM, was used to induce colon carcinogenesis, so bMO in the diet might act via the carcinogenesis processes through metabolic activation [7]."

Concluding Remarks

We have discussed some real positive effects on the use and efficacy of Moringa Oleifera as anticancer treatment. Nonetheless, further studies and procedures to maximize such positive impact of MO as anticancer should be continued.

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