Research Article

Design, development and evaluation of nutraceutical *Moringa oleifera* tablet

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Received: 4 April 2022 Revised: 11 June 2022 Accepted: 28 June 2022

Abstract

Aim: The goal of this study is to find an appropriate binder for a standard dose of aqueous extract of *Moringa oleifera* leaves and package it into tablets. **Material and Methods:** Aqueous extracts of *Moringa oleifera* leaves were extracted and manufactured using a variety of binders, including Maize Starch, Gelatin, and Micro-crystalline Cellulose (MCC), to see which one produced the best tablets of aqueous extracts of *Moringa oleifera* leaves. Physicochemical qualities (bulk density, tapped density, moisture content, Hausner's ratio, Carr's index, ash value), strength (friability and crushing strength), and release properties were used to describe the formulations (disintegration and dissolution times tests). **Results**: In comparison to tablets produced with MCC or maize starch, those manufactured using Gelatin as a binder had the lowest friability and disintegration time. Except for maize starch, which had a greater crushing strength, all of the crushing strengths were within the permitted range (3–6 KgF). **Conclusion:** *Moringa oleifera* tablets were effectively created, and based on the results of the research, Gelatin is preferred for *Moringa oleifera* tablet formulation.

Keywords: *Moringa oleifera,* drumstick, miracle tree, cosmetics, food supplement

Introduction

Moringa oleifera is a widely spread and naturalised member of the Moringaceae family (Ramachandran et al., 1980), which contains 13 tree and shrub species found in the sub-Himalayan regions of India, Sri Lanka, Africa, and Arabia (Adedapo et al., 2009). The tree grows to a height of 5 to 10 metres (Morton et al., 1991) and can be seen growing wild and farmed on the plains, particularly in hedges and home yards.

It contains several vitamins and minerals, as well as other phytochemicals such as carotenoids. Two alkaloids, moringine and moringinine, have been found in the stem bark (Kerharo et al., 1969). The plant's stem has yielded vanillin, beta sitosterol, beta sitostenone, 4-hydroxymellin, and octacosonoic acid (Faizi et al., 1994). 9 amino acids, sucrose, D-glucose, traces of alkaloids, wax, quercetin, and kaempferat are all found in flowers. Flavonoid pigments including kaempherol, rhamnet, isoquercetin, and kaempferitin have also been found in them (Faizi et al., 1994). The plant's leaves are the most nutritional portion, including vitamin B6, C, provitamin A as beta carotene, magnesium, and protein, among other minerals (Dillard et al., 2000). Moringa has been utilised in traditional medicine, particularly ayuverdic medicine. Various portions of this tree have been attributed with therapeutic virtues for use in a variety of diseases (Abd Rani et al., 2018).

It's used to treat infections, urinary tract infections, Epstein-Bar virus (EBV), Herpes simplex virus (HSV-1), HIV/AIDS, hepatitis, helminths, trypanosomes, bronchitis, external sores/ulcers, and fever, among other things. It possesses anti-tumor, anti-prostate, anti-anemia, anti-hypertensive, antidiabetic, diuretic, antioxidant, and antiseptic properties. Hypercholesterolemia, thyroidism, colitis, diarrhoea, dysentery, ulcer/gastritis, rheumatism, headache, iron deficiency, vitamin/mineral insufficiency, improve lactation, catarrh, malnutrition, weight loss, and

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DOI:https://doi.org/10.31024/apj.2022.7.3.3

scurvy have all been reported to be treated with the plant.

When consumed for a short time, the leaf has been deemed safe by numerous writers (Okechukwu et al., 2013). When the leaves are consumed for a lengthy period of time, organ toxicity has been documented. Because the acute toxicity (LD50) of aqueous extract of 16.1 g/kg has previously been described (Kosolo et al., 2012), a 50 milligramme dosage was chosen for the formulation. Before being used in illness therapy, the leaves are usually steeped in water or alcohol (ethanol). The inclusion of additional substances causes difficulties in the formation of powdered leaves (Muazu et al., 2013). As a result, the study's focus was on aqueous leaf extract. Herbal tablets containing Ipomea digitata, for example, have been prepared into several dosage forms for ease of administration and to standardise the dose of the formulation (Chandira et al., 2010).

The goal of this study is to manufacture a standardised amount of aqueous extract of *Moringa oleifera* leaves into tablets and find a suitable binder for the formulation so that *Moringa oleifera* may be utilized as an alternate dosage form.

Materials and methods

Materials

Materials *Moringa oleifera* extract from *Moringa oleifera* leaves, Magnesium stearate (Cipla Limited, Indore, India), Talc (Cipla Limited, Indore, India), Lactose (Cipla Limited, Indore, India), Micro crystalline Cellulose (Cipla Limited, Indore, India), Gelatin (Cipla Limited, Indore, India).

Collection and identification of *Moringa oleifera*

Moringa oleifera leaves were obtained from local area of Barela, Jabalpur, Madhya Pradesh, India. It was later authenticated by a taxonomist from the Department of Botany, JNKV University, Jabalpur, Madhya Pradesh, India.

Extraction of *Moringa oleifera* leaves

In the Pharmaceutics laboratory, fresh Moringa leaves were shade dried for three days. Using a mortar and pestle, the stalks were removed and the leaves were cut in size. The dry powder's weight was recorded. The rotary extractor was used to obtain an aqueous extract, which was dried for 3 days at room temperature at a temperature of 27°C. The extract was weighed, then the size was decreased with a porcelain mortar and pestle to determine the percentage yield. The powder was sieved, and the portion that went through a 180 m sieve was employed in the experiment.

Characterization of *Moringa oleifera* powder

Moisture content

A moisture analyzer was used to assess the moisture content of *Moringa oleifera* powder. The powder was placed into the moisture balance at a weight of 3 g and uniformly spread on the tray. The temperature of the machine was set at 130°C. When the machine stopped automatically, the readings were recorded. The experiment was done twice more, with the moisture content calculated as the average of the three values.

Angle of repose

A glass funnel clamped on a retort stand 10 cm away from the bench's smooth surface was used to evaluate the powder's angle of repose. In the funnel, 30g of powder was poured and allowed to flow freely, generating a conical mound. Using the formula, the angle of repose was estimated from the powder heap;

Angle of repose **(θ)** **$\tan \theta = h/r$**

Where h= height of the heap and r= radius of the circular heap.

The experiment was repeated twice and the average of the three readings was taken as the angle of repose.

This was carried out by measuring the volume occupied by a 30g weight of the powder in a dry measuring cylinder. The bulk density Bd was calculated using the formula:

Bd=Wp/Vp

Where Wp = Weight of the powder, Vp = Volume occupied by the powder

The tapped volume was measured after the measuring cylinder was tapped 50 times on a hardwood table from a height of around 2cm. Td, the tapped density, was computed as follows:

Td=Wp/Vp

Tapped volume occupied by *Moringa* powder

The experiment was repeated twice and the average of the three readings was taken as the value of bulk and tapped densities.

Preparation of the *moringa* granules

The *Moringa* granules were prepared by the wet granulation method according to the working formula in (Table 1).

As a disintegrant, each formulation (F1 to F4) contains 12.2 mg maize starch. The disintegrants were mixed in with the granules. Furthermore, maize starch was employed as a binder in F1.

50 g of *Moringa oleifera* powder, 85.5g of lactose and 12.2 g of maize starch were weighed.The batches were small (100 tablets per batch), mixing was done for 10 min, the extract and other exipients were mixed thoroughly.

Table 1. Working formula for *Moringa oleifera* tablets

Ingredient binders	Maize Starch (F1)	MCC (F2)	Gelati (F3)	Control (F4)
Moringa extract (mg)	56.1	56.0	52.0	53.0
Lactose (mg)	85.5	85.5	88.7	95.5
Maize Starch (mg)	12.2	12.2	12.2	12.2
Binder (mg)	8.1	8.1	4.9	0
Talc (mg)	3.5	3.5	3.3	3.3
Mg Stearate (mg)	0.4	0.3	0.4	0.3
Theoretical Weight (mg)	161.0	161.0	161.0	161.0

Key: MCC = Microcrystalline Cellulose

Preparation of binder solution: 5% w/v of starch paste was prepared by weighing 5 g of binder maize starch powder and dispersed into 30 ml of distilled water. It was then added to a boiling distilled water placed on a hot plate with continuous stirring until translucent paste was formed. The final 100 ml mark was made with distilled water and allowed to cool.

Addition of binder: Small quantity of the paste was added gradually to the powder mixture until moistened mass was formed.

Wet screening: The moistened mass was passed through a 1.7 mm sieve.

Drying: The wet granules were dried in a hot air oven at 40°C

Dry screening: The granules were then passed through 1.4 mm sieve and oversize granules were size reduced. Same was done for F3 but for F2, MCC was added in dry form. For F4 distilled water was used instead of binder solution. The granules were then characterized.

Granule characterization

The following tests (Angle of repose, Bulk density, Tapped density and Moisture content) were carried out as earlier described for *Moringa* powder on the granules produced prior to compression into tablets.

Compression of granules into tablets

The granules were then mixed with talc and magnesium stearate prior to compression. The granules were compressed into tablets on single punch tablet press, using die and flat punch set of diameter 8 mm at compressional force of 6 metric tons to produce circular tablets. The tablets were kept in air tight containers for 48 hr prior to quality control tests.

Quality control on the formulated tablets

Uniformity of Thickness and Diameter

Vernier Calliper was used to measure the diameter and thickness of the tablets. The mean value of five determinations was recorded in each case. The experiment was repeated twice and the average of the three readings was taken as the thickness/diameter.

Uniformity of Weight Test

Twenty tablets were randomly selected and weighed individually. The mean weight of the tablets was then

Table 2. Physicochemical properties of *Moringa oleifera* powder

S/no	Parameters	*Moringa oleifera* powder
1	Moisture content (%)	2.88±0.65
2	Angle of repose (°)	24.00±1.38
3	Bulk density (g/ml)	0.98±0.03
4	Tapped density (g/ml)	1.23±0.13
5	Carr's index (%)	17.90±0.93
6	Hausner's ratio	1.25±0.09
7	Ash value	0.25±0.25
8.	Percentage Yield (%)	13.28±1.09

Table 3. Physicochemical properties of *Moringa* granules

Formulation	Angle of repose (°) ±SD	Bulk Density (g/ml) ±SD	Tappeddensity (g/ml) ±SD	Carr'sindex ±SD	Hausner's ratio ±SD	Moisturecontent ±SD
F1	15.07±0.38	1.09±0.024	1.24±0.03	12.3±0.06	1.16±0.02	1.78±0.01
F2	22.55±1.10	0.59±0.015	0.67±0.01	9.3±0.01	1.11±0.02	2.01±0.01
F3	22.12±0.68	0.62±0.022	0.66±0.01	6.3±0.01	1.08±0.02	1.59±0.01
F4	18.25±0.90	0.62±0.005	0.66±0.01	6.17±0.01	1.08±0.02	1.66±0.02

Key F1=maize starch, F2=MCC, F3=Gelatin and F4=control; MCC = Microcrystalline cellulose

calculated and the standard deviation determined.

Crushing Strength

The hardness tester was used in measuring the hardness of the tablets. Six tablets were selected at random and each tablet was in turn placed between the anvil and the spindle of the hardness tester and subjected to increasing pressure by turning the knurled knob in a clockwise direction at constant rate until the tablet was crushed. The value of the pressure applied (KgF) was taken as the Crushing Strength of the tablet. The mean of six determinations were taken.

Friability Test

Twenty tablets were randomly selected and weighed accurately. They were then placed inside the drum of Friabilator and operated for four minutes at a speed of 25 rpm. The intact tablets were removed from the drum, dusted and weighed. The percentage loss in weight was calculated and recorded as friability value.

Disintegration Time Test

Six tablets were randomly selected and placed individually in the six tubes of the rack of the disintegrating machine. The rack was then raised and lowered at constant rate in distilled water contained in a glass jar suspended in a water bath whose temperature was thermostatically maintained at 37±1°C. The time taken for the last tablet or its fragment to pass through the 2 mm mesh into the disintegrating medium (distilled water) was recorded as the disintegration time.

Dissolution Time Test

The calibration curve was constructed using the *Moringa oleifera* extract and 0.1M HCl as the dissolving medium, 10mg of the extract was weighed and diluted in 150 ml of 0.1M HCl 0.5, 1.0, 1.5, 2.0, 2.5ml of the stock was then re-diluted in 5 ml volumetric flask to give 6.66, 13.33, 20, 26.67, 33.33µg/ml concentrations respectively. The absorbance of the different concentrations was spectrophotometrically determined at 205.1nm wavelength using a UV spectrophotometer a graph of absorbance against concentration was plotted.

The ash value of *Moringa* extract as shown in (Table 2) indicates that there is the presence of organic salts e.g calcium oxalate found naturally in drugs as well as inorganic matter derived from external sources. Ash value test is one of the most important tests in the examination of powdered drugs.

Characterization of Granules

(Table 3) shows the results of various tests carried out on the granules produced using different binders.

The flow properties of the granules were generally better than those of *Moringa* powder. This can be explained presence of binder tends to produce denser granules which are larger than the powder particles. The larger the size of powder particle, the smaller the surface activity and hence the better flow (Wells et al., 2007). Although all the binders fall within the normal range of below 23º (Ohwoavworhua et al., 2004), the best binder to use is maize starch because it has the lowest value which indicates a better flow ability than the rest of the binders.

Quality Control of Formulated Tablets

The results shows in (Table 4) the quality control tests carried out on *Moringa* tablets produced with different binders. The tablets have uniform diameter and thickness which conforms to the specification which states that the range of tablet thickness should be between ±5% (Troy et al., 2007). The result of the uniformity of weight (Table 4) as observed showed that the tablets have a standard deviation of less than 0.1 which conforms to the standard set by the USP which stipulates that the limit should not exceed 7.5% for tablets weighing between 130-324 mg.

All the formulations fall within the acceptable crushing strength range of 3-6 KgF (Gupta et al., 2004) except F1

Table 4. Physicochemical properties of the *Moringa oleifera* tablets

Parameter	MCC	Maize starch	Gelatin	Control
Thickness (mm)	5.13±0.15	5.09±0.06	5.04±0.11	4.98±1.27
Diameter (mm)	8.04±0.18	8.17±0.58	8.10±0.03	8.09±0.43
Weight (g)	0.164±0.03	0.154±0.01	0.155±0.01	0.157±0.01
Crushing strength (Kg/F)	4.07±0.43	7.20±0.19	4.5±0.15	3.64±0.02
Friability test (%)	0.39±0.01	0.39±0.04	0.24±0.05	0.25±0.18
Disintegration time (min)	21.97±0.40	17.59±0.40	11.64±0.80	11.63±0.80
CSFR (Crushing Strength Friability Ratio)	10.69	18.46	18.75	14.56
CSFR-DT	0.49	1.05	1.61	1.25

Key: CSFR = Crushing Strength Friability Ratio, DT = Disintegration Time

(when maize starch was used as binder). There was significant difference between F4 (control) and either F1, F2 or F3 ($p<0.05$). From the friability test as shown in the (Table 4), all the tablets fall within acceptable compendial range. There was no significant difference between F4 and F3 ($p>0.05$) but there was significant difference between F3 and either F1 or F2 ($p<0.05$). Therefore, the best formulation is F3 (i.e the binder of choice is Gelatin) because it has good impaction ability and is less friable. It is pertinent to note that formulation F3 containing no binder passed both friability and crushing strength tests. It was as a result of proportion of the starch added as disintegrant being wetted in the process of granulation thereby acting as binder.

As shown in (Table 4), Gelatin has the highest disintegration time probably because it has a lower concentration of binder. As a result, it is preferable in the production of *Moringa* tablets because it has a better disintegration profile which is the rate determining step in drug absorption

(Musa et al., 2008). There was significant difference between F3 and either F1 and F2 ($p<0.05$). The values of crushing strength and friability provide measures of tablet strength and weakness, respectively. Thus, the CSFR can he used as a measure of the mechanical strength of the *Moringa* tablets, the higher the CSFR, the stronger the tablets. The result of CSFR showed tablets produced with gelatin as binder has better mechanical strength. The ranking is gelatin>maize starch>MCC.

The effects CSFR on disintegration time of the tablets has also followed same pattern. The CSFR-DT values ranking was gelatin>maize starch>MCC for the *Moringa* tablets. This is an indication that gelatin is better binder to be used in the formulation of the *Moringa* tablets.

Dissolution is the time taken for a tablet to go into solution and a tablet must first disintegrate before it goes into solution (Musa et al., 2008). Illustrates the dissolution profile of the various tablets containing different binders with Gelatin having the best dissolution profile (up to 100%) and therefore, can be declared as the better binder in the production of *Moringa oleifera* tablets. However, it should be noted that a tablet can disintegrate rapidly but still have delayed dissolution profile due to the fact that it can actually disintegrate into hard coarse particles from which dissolution may be slow (Musa et al., 2008).

Conclusion

A 50 mg *Moringa oleifera* tablet was successfully formulated from aqueous extract of *Moringa oleifera* leaves. It can therefore be concluded that *Moringa oleifera* can be tableted using different binders and still get promising results. Based on experiments conducted, the binder of choice for producing *Moringa oleifera* tablets is Gelatin as it has passed all the tests required. Further studies should be carried out on Mechanical Strength and Lamination tendencies of *Moringa* tablets.

Conflict of interest: Not declared

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