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Variation of Different Drying Characteristics of *Moringa* Leaves on Different Drying Methods

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ABSTRACT

Moringa oleifera, one of the multipurpose utility trees, is widely cultivated in different regions of India and throughout the World. M.o.l. belongs to M.o.l family and known with the various names according to their origin and local dialect. Different parts of M.o.l.tree are widely used as source of as multi-nutrition, multi-vitamins and medicinal compounds. M.o.l. are one of the edible parts of the tree carrying a bundle of nutrients and multi-vitamins. The present investigation focused on evaluating the physic-chemical properties of M.o.l. leaves, study of drying behaviour of M.o.l. using different drying methods namely shade drying, hot air oven drying (40, 50, 60 & 70˚C) and microwave drying (300, 450 & 600 W). Also, analysis of the nutritional and proximate composition such as fat, protein, ash, fiber, carbohydrate and energy value, mineral fractions viz. calcium, magnesium, iron and zinc and vitamins of dried M.o.l. were carried out. The weighted M.o.l. were taken and dried in different drying methods and conditions. The weight reduction of the samples was measured periodically until the constant weights were observed.

The minimum drying time required in microwave drying takes 12-16 minutes, and the maximum drying time is required in the shade drying i.e., 34 hours. Shade drying performance was better as compared to sun drying but required comparatively longer drying time. In a hot air oven 50˚C drying temperature was found to be optimum with better quality retention but comparatively higher drying as compared to microwave drying. During microwave drying, 300 Watt was found to be optimum for drying of moringa leaves.

Keywords: *Moringa, Healthy diets, Diseases, Microwave,*

INTRODUCTION

Healthy diets are good health and healthy lifestyle trending nowadays. It has been proven that healthy diets are only responsible for reduced risk of diseases like cancer, heart problem and malnutrition. Green Leafy Vegetable (GLV) is one of the most common parts of a healthy diet requiring a balanced diet due to high amount of fiber and medicinal purpose daily.

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Usually, GLV have been used as partially cooked and boiled as soup as well as cooked vegetables "*Tarkari*" in delicious Indian cuisines. Fresh and cooked GLV are incorporated in the diet menu to fulfill the nutritional requirement of human beings. All the GLV are rich sources of vitamins such as ascorbic acid, β-carotene, riboflavin and folic acid as well as minerals such as calcium, iron, sodium, potassium, magnesium and phosphorous. Magnesium is a mineral necessary for maintaining muscle health, as well as bone formation helping the absorption of calcium. Green leafy vegetables are also recognized for their intrinsic aesthetic characteristics like colour, flavor, and therapeutic value. GLV have been cited as a potential source of micronutrients, particularly carotenoids, that are absorbed and transformed into vitamin-A in the human body. Also, GLV are a good source of natural fiber, that helps to improve the digestive system and slowing the rate of sugar absorption in the human body. Moreover, frequent consumption of GLV boost digestive enzymes in human digestion system (Gupta et al., 1988) (Joshi, P., & Mehta, et al., 2010) (Kadam, D. M., Goyal, R. K., Singh, K. K., & Gupta, et al., 2011).

Nature has gifted a variety of green leafy vegetables that are easily available and easy to use. Some of the commonly consumed leafy vegetables are amaranth, spinach, fenugreek, *M.o.l.* leaves, coriander leaves, *etc*., which may be seasonal or perennial (Gopalan et al., 1996). Green Leafy Vegetables are considered as cheapest sources of bundle of nutrients and vitamins.

India is the prime producer of *M.o.l.* (drumstick) with an annual production of 2.20 to 2.40 million tons of tender fruits from an area of 38,000ha leading to the productivity of around 63 tons per ha. Among the different states, Andhra Pradesh leads in both area and production (15,665ha) followed by Karnataka (10,280ha) and Tamilnadu (13250ha). In other states, it occupies an area of 4,613ha (Sekhar et al., 2018) (Arora, D. S., Onsare, J. G., & Kaur, et al., 2013). In general, drumstick production in the southern region has gained much impetus as compared to other parts of the country. Recently, Kerala has evolved advanced production and protection technologies as well as improved varieties of annual *M.o.l.*, thus enabling the multifold increase in the production of drumstick in the state. Chhattisgarh region *M.o.l.* tree is known as “munga" in local dialect. In Chhattisgarh, the area under drumstick production was 2468 ha with an annual production of 16462 MT. The highest area 783 ha covered for *M.o.l.* cultivation is Korba district in Chhattisgarh.

Specific vegetables may offer more health advantages to certain people, depending on their diets, overall health, and nutritional needs. Spinach is a leafy green vegetable and a great source of calcium, vitamins, iron, and antioxidants; Peas contain 134 calories, carrots contains 52 calories Trusted Source and vitamin A, Tomatoes contain lycopene, a powerful antioxidant. that lycopene may help prevent prostate cancer, and the beta carotene in tomatoes also helps combat cancer (A. O. A. C. et al., 2005) (Arora, D. S., & Onsare et al., 2013).

M.o.l. has been used as a traditional medicine around the World for anaemia, skin infections, blackheads, anxiety, bronchitis, catarrh, chest congestion, asthma, blood impurities, cholera, glandular, swelling, headaches, conjunctivitis, cough, diarrhoea, eye and ear infections, fever, abnormal blood pressure, hysteria, pain in joints, pimples, psoriasis, respiratory disorders, scurvy, semen deficiency, sore throat, sprain, tuberculosis, for intestinal worms, lactation diabetes and pregnancy.

They contain high amount of vitamin C, which fights a host of illnesses including colds and flu, vitamin A, which acts as a shield against eye disease, skin disease, heart ailments, diarrhea, and many other diseases.

The production of drumstick in the state of Chhattisgarh region *M.o.l.* tree is known as “munga" in local dialect. In Chhattisgarh, the area under drumstick production was 2468ha with an annual production of 16462MT. The highest area 783

ha covered for *M.o.l.* cultivation is Korba district in Chhattisgarh.

Drumstick in the state of Chhattisgarh due to obtain health benefit of *M.o.l.* have contain various nutrition values so their drying characteristics behaviours studies are significant for their preservation & further value addition. The drying characteristics or drying methods such as sun drying, microwave drying, hot air drying methods were studies and drying rate, drying time where calculated & physiochemical properties. The moisture content dry matter was determined drying the experiment. (Sahu, G., Vinoda, N., Monisha, P., Paradkar, V., & Kumar, et al., 2017), (Razis, A. F., Ibrahim, M. D., & Kntayya, S. B. et al., 2014.), (Mahima et al., 2014), (Pandey A. K. et al., 2011). (Arora, D. S., & Onsare et al., 2013), (Pandey et al., 2011).

MATERIALS AND METHODS

The fresh, mature, dark green and healthy leaves of *M.o.l.* was procured from nursery avifter ensuring the fresh and healthy one by visual appearance by own place Pondishankar Janjgir Champa.The *M.o.l* were selected for study on the basis of physical properties of fresh and healthy leaves like dark green Colour.

Proximate composition

Proximate compositions of fresh and dried *M.o.l* were determined using standard procedure cited by several researchers.

1. Moisture content

The Moisture content of *M.o.l.* was determined by using standard hot air oven method (AOAC 2000) frequently (Mahima et al., 2014) (Anwar, E. S., & Latif, et al., 2007) (Sekhar et al., 2018).

Moisture content, % (wb) =

Moisture content, % (db) =

Total weight (W) = $W_w + W_d$

Where,

wb = wet basis, (%) db = dry basis, (%)

W_1 = Initial weight of the sample, (g)

W_2 = Final weight of the sample, (g)

W_w = Weight of water, (g)

W_d = Weight of dry matter, (g)

2. Fat Content

The fat content of *M.o.l.*was determined using Soxhlet Plus solvent extraction unit (SOCSPLUS SCS-03E) (Mahima et al., 2014) (Pandey et al., 2011).

3. Protein Content

Protein was determined followed by Micro-Kjeldahl method (Mahima et al., 2014) (Ali, et al., 2014.) (Sekhar et al., 2018).

Nitrogen (%) =……

Amount of protein % = nitrogen (%) × 6.25

4. Ash Content

Ash content of *M.o.l.* was determined by using a muffle furnace (Mahima et al., 2014) (Sahu, G., Vinoda, N., & Monisha et al., 2017) (Pandey et al., 2011).

5. Carbohydrate Content

The carbohydrate content was determined by subtracting the sum of percentage of moisture content, crude fiber content, protein content, fat content, and total ash content from the hundred. (AOAC2000) (Mahima et al., 2014) (Kadam, D. M., 2011).

Carbohydrate content = [100 – (moisture content + crude fiber content + protein content +fat content + ash content)]

6. Energy Value

The total energy in kilocalories/100g was determined by following formula. (Asibey & Taiye, 1999) (Anwar, E. S., & Latif, et al., 2007).

Kcal/100 g = 4 % protein 9% fat 4% carbohydrate

7. Chlorophyll

Chlorophyll content determination UV-VIS Spectrophotometer (Model-3375) (Gogoi & Basumatary, 2018) (Pandey et al., 2011).

Chlorophyll „a‟ (mg/g) = 12.7(A663) – 2.69(A645) ×V/1000×W

Chlorophyll „b‟ (mg/g) = 22.9× (A645) – 4.68 (A663) × V/1000×W

Total chlorophyll (mg/g) = 20.2× (A645) – 8.02× (A663) × V/1000×W

Where,

A = absorbance at specific wavelength

V = final volume of chlorophyll extract in 80% acetone W = fresh weight of tissue extracted

8. Colour

Colour of the *M.o.l.*were measured by a colorimeter CR-10 (Konica Minolta, INC.

Japan) (Altan et al., 2008) (Sekhar et al., 2018).

9. Ascorbic Acid

Ascorbic acid of the M.o.l. was measured using titration method (Arora, D. S., & Onsare et al., 2013) (Pandey et al., 2011).

Drying Characteristics of *M.o.l.*

1. Drying of *M.o.l.*

Drying of fresh M.o.l. were carried out by using different drying method namely Shade drying (at ambient condition), Hot air oven drying at different temperatures (40˚C, 50˚C, 60˚C,70˚C), Sun drying, Solar drying, and Microwave oven drying at different wattage and constant hot air circulation (300, 450 & 600 W + 40 ˚C). The initial moisture content of fresh M.o.l. was estimated by hot air oven at 103±2˚C for 24 hours.

1. Dry matters

The initial moisture content of samples was determined by oven drying method, (Sahu, 2015) (Jain, et al., 2017) (Sekhar et al., 2018).

DM (%) = 100 - IMC (wb) (16)

Where,

DM = dry matter, (%)

IMD = initial moisture content, (wb)

2. Drying rate

The moisture content data recorded during experiments were analyzed to determine the moisture lost from the sample of *moringa* leaves in particular time interval. The drying rate of samples was calculated by following equation (Kadam et al., 2011) (Sekhar et al., 2018).

Drying rate = $\Delta w/\Delta t$

Where,

Δw = difference in weight, (g)

Δt =difference in time, (min) dm = dry matter, (g)

3. Moisture Ratio

The moisture ratio (MR) was determined by the following equation. (Doymaz & Ismail, 2011; & Goyal et al., 2007) (A. O. A. C., 2005) (Sekhar et al., 2018).

Moisture ratio MR = $M - M_{EQ} / M_0 - M_{EQ}$

Where,

M = Moisture content at any time, (%db) Mo = Initial moisture content, (%db)

Me = equilibrium moisture content, (%db)

Me in comparison to Mo and M is very small, hence Me was neglected.

RESULTS AND DISCUSSION

Determination of Physiochemical properties of fresh *M.o.l.*

Physiochemical properties of fresh *M.o.l.* were determined by measuring their proximate composition and quantification of minerals.

Effect of hot air oven drying on *M.o.l.*

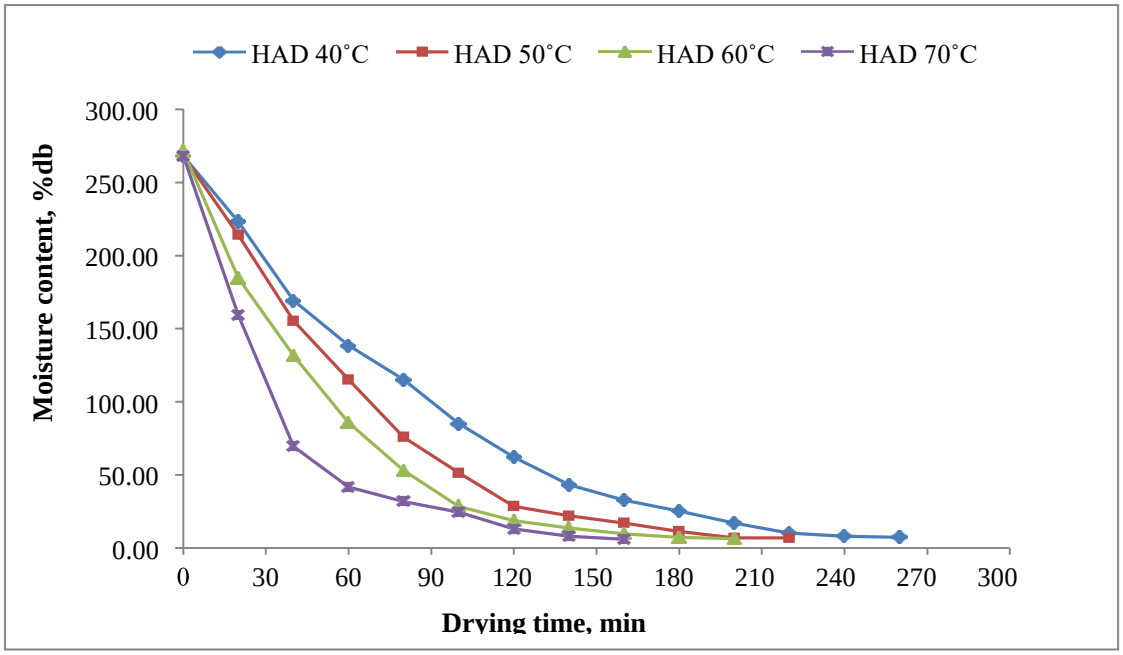

Fig: Effect of different drying air temperature on drying characteristics of *M.o.l.*in hot air drying

The effect of hot air drying on quality characteristics of *moringaoleifera* leaves were studied using hot air dryer at different hot air temperature (temperature ranges from 40 to 70˚C). From the experimental data, it was found that hot air drying of fresh *moringa* leaves comparatively taken lower drying time than other methods. The time taken for drying the *moringa* leaves by hot air drying at 40, 50, 60 and 70˚C was found to be 260, 220, 200 and 160 minutes respectively the moisture content ranges maximum 6% and minimum 3.25% (the similar finds on drying characteristic of *moringaoleifera* leaves dried in hot air drying was repeated by Joshi et al., 2010).

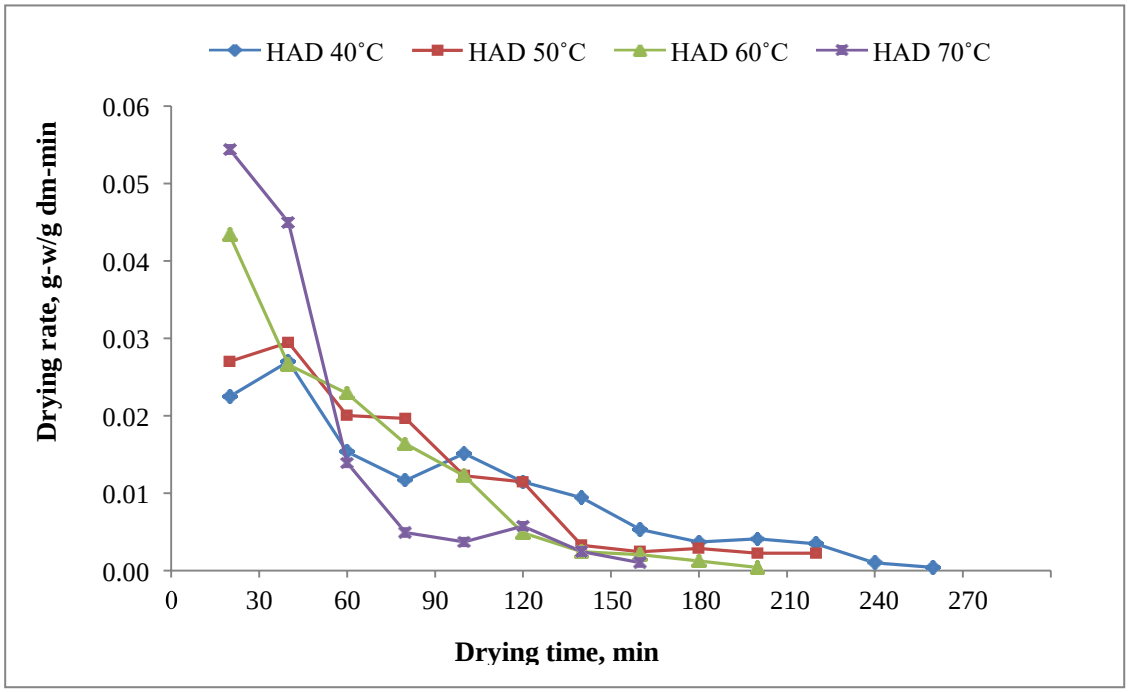

Fig: Drying rate vs time curve of *moringaoleifera* leaves in hot air drying with different drying temperatures

The effect of hot air drying on quality characteristics of *moringaoleifera* leaves were studied using hot air dryer at different hot air temperature (temperature ranges from 40 to 70˚C). From the experimental data it was found that hot air drying of fresh *moringa* leaves comparatively taken lower drying time and dry rate. The time taken for drying the *moringa* leaves by hot air drying at 40, 50, 60 and 70˚C was found to be 260, 220, 200 and 160 minutes respectively.

Drying rate ranges from 0.01g-w/g dm-min and 0.05g-w/g dm- min. the drying rate higher H.A.D. 70°C and the time taken to maximum. The drying rate at lower H. A. D. 40°C time taken to minimum.

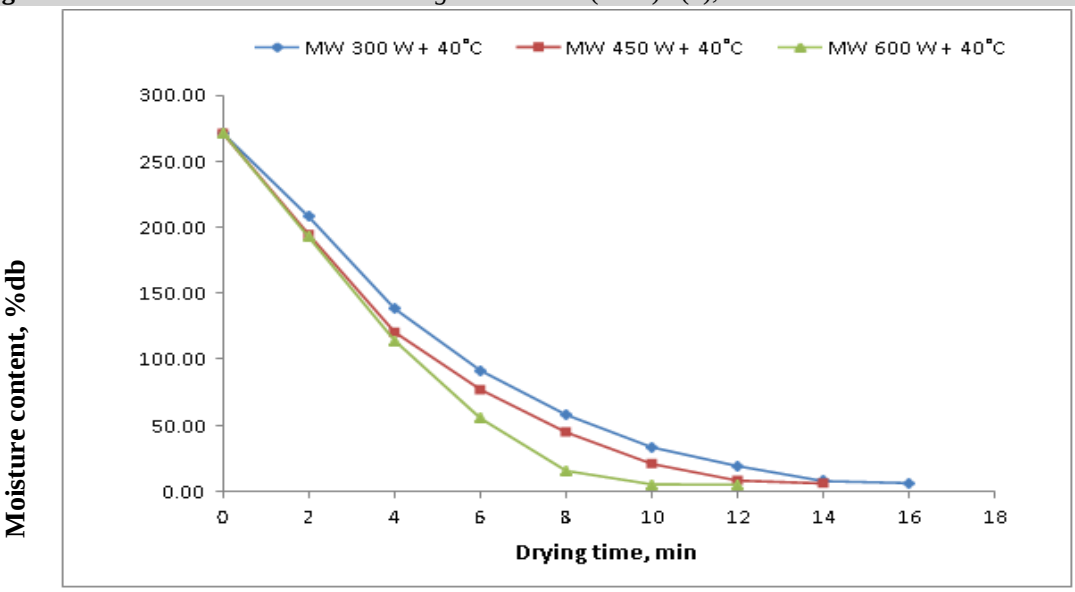

Fig.: Variation of moisture content during different time interval on microwave drying

Effect of micro oven drying temperature on drying characteristics of *moringaoleifera* leaves was studied and well explained using the above curves. Fig. shows that the plot between the moisture content vs drying time at different drying air temperature. As shown in figure that initially the rate moisture removal was higher due to higher moisture was available to convert in the form of vapour later decreases gradually with the passage of time. Also, it was noticed that drying temperature regulates the drying time in the case of micro oven drying because as the air temperature increased, the drying time was decreased and vice-versa. The drying redeploy between the quantity of water removed per unit time versus drying time was studied and noticed that the drying rate was increasing up to a certain level and subsequently decrease as drying proceeds. The minimum temperature microwave 300WT + 40°C and maximum 600WT + 40°C.

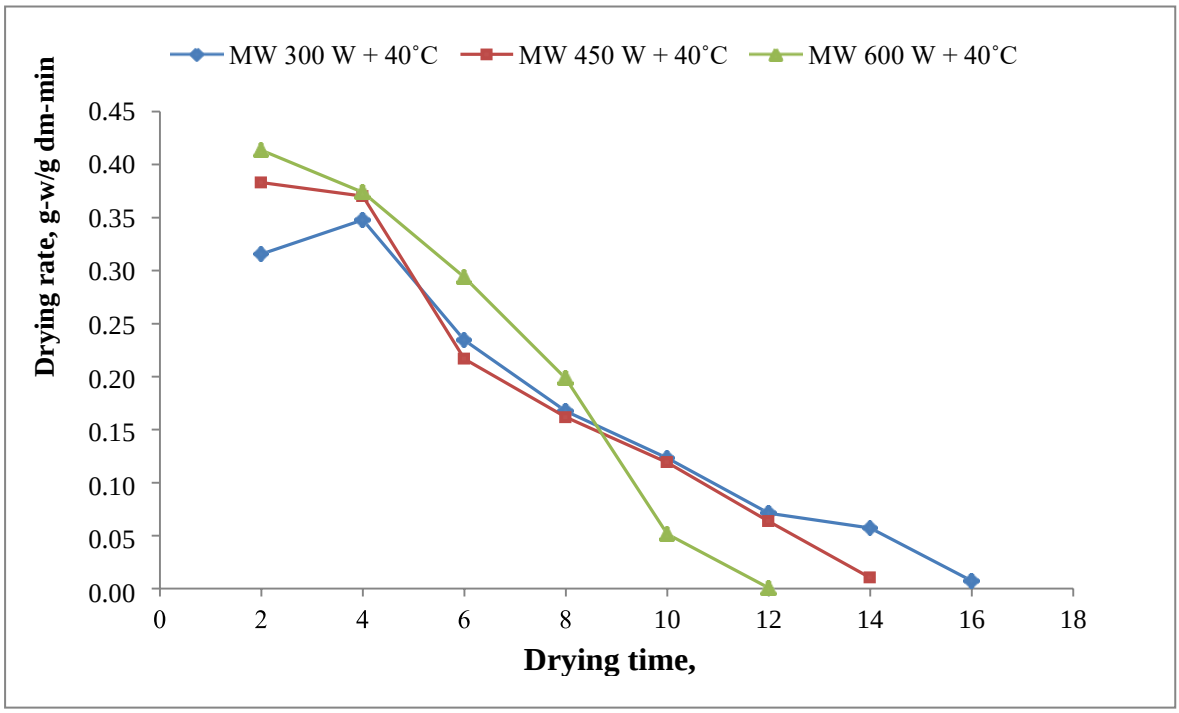

Fig.: Drying rate vs time curve of *moringaoleifera* leaves in microwave drying using with different watt power & constant temperature

In microwave drying are used for drying. Fresh *moringa* leaves were carried at different microwave wattage 300W, 450W & 600W at 40˚C constant hot air convection. From the drying data, it was noticed that drying at 300 watts for 14 minutes gives superior quality characteristics of dried *moringa* leaves. Also, it was found that the time taken for drying the *moringa* leaves by microwave drying at 300W, 450W and 600W at 40˚C constant convection temperature was found to be 14, 14 and 12 minutes respectively final drying are reached at 12-14 minutes and the final moisture content of the samples were ranged from 6.27 to 5.18 (%db). Final moisture content as follows 5.9, 5.85, & 4.92% (%wb) at 300W, 450W and 600W respectively. Maximum proximate, minerals & vitamin composition was found in 300W + 40˚C the final 5.9% of wet basis sample as compare to other watt drying samples. Overall performance was best at removing electricity consumption in dried at 300W + 40˚C sample compared to other watt drying samples.

CONCLUSION

The above study physic-chemical properties of *moringa* leaves, drying characteristics of *moringa* leaves in different drying methods such as hot air oven drying, shade drying, sun drying, drying and microwave drying and analyze the nutritional composition such as proximate composition fat, protein, ash, fiber, carbohydrate and energy value mineral fractions viz. calcium, magnesium, iron and zinc and vitamins of dried *moringa* leaves. The minimum drying time required in microwave drying takes 12-16 minutes and the maximum drying time required in shade drying takes 34 hours. After drying of dried leaves samples all nutrition composition were increases except vitamin content. Shade drying performance are better as compare to sun and solar conduction drying but its required to much time as compare to other method. In hot air drying dried at 50˚C sample as compare to other drying temperatures and in microwave drying dried at 300 watt sample was found better as compare to other dried at watt samples. Overall performance and quality characteristics was found better in the hot air drying method dried at 50˚C sample as compared to other drying methods.

The result of analysis of variance on the certain retained for the study involving the reducing drying rate to evaluate the effect of treatment on the product quality and the maximum drying rate and final time for the evolution of the process. the factor having the most effect on the variance of reducing temperature. The variance of maximum drying rate was explained by two factor variety. The microwave drying different factor on the variance of different retain criteria reducing *moring* leaves maximum drying rate duration of drying time. A small effect 6% of the forward backwards frequency of the conveyer and product shape.

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Conflict of Interest:
There is no such evidence of conflict of interest.

Author Contribution:
All authors contributed equally to establishing the research and design experiment topic.

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