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Optimization of *Moringa* biscuits by using *Moringa* (*Moringa oleifera*) leaf flour and oat flour

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Abstract
The present research work is evaluated with different formulation of biscuits by using *Moringa* (*Moringa oleifera*) leaf flour and oat flour. It is one of the most important trends in food and pharmaceutical industries and it has growing demand for valuable natural sources of nutritional compounds. In the current study, *Moringa* leaf flour was added at different levels *viz.,* 1.5% and 2.5% with 4 different treatments i.e., T_1 with 1.5% *Moringa* leaf flour, T_2 with 2.5% *Moringa* leaf flour, T_3 with 1.5% *Moringa* leaf flour and oat flour and T_4 with 2.5% *Moringa* leaf flour and oat flour and other ingredients are kept at constant and control was used as standard. The sensory evaluation of biscuits given a clear indication that treatment T_3 (1.5% *Moringa* leaf flour + oat flour) was found more acceptability compared with other treatments. Addition of *Moringa* leaf flour and oat flour in the formulation for preparation of biscuits is important to obtain a product with rich in calcium and iron.

Keywords: Optimization, *Moringa* leaf flour, oat flour, sensory evaluation

Introduction
Moringa (*Moringa spp*.) belongs to a monogenetic family *Moringaceae*. *Moringa oleifera* is also known as "Miracle Tree" (Kumari *et al.*, 2006) [11]. *Moringa oleifera* has a host of other country specific vernacular names, an indication of the significance of the tree around the world (Sharma *et al.*, 2006) [21]. It is a small fast-growing ornamental tree originally belongs to India. Drumstick trees (*Moringa oleifera*) are one of the world's most useful tropical trees. Presently, it is one of the most important trends in food and pharmaceutical industries and it has growing demand for valuable natural sources of nutritional compounds. The leaves, seeds and flowers of *Moringa oleifera* have great nutritional and therapeutic value (Olushola, 2006) [17]. The seeds are eaten like peas or roasted like nuts when still green. The leaves are outstanding as a source of vitamins A, B group, (C when raw) and are among the best sources of minerals. They are also excellent sources of protein, but poor sources of carbohydrate and fat. *Moringa* leaves are one of the best plant foods available in nature. The leaves can be cooked and eaten as a vegetable like spinach. More often, they are dried and ground into flour and used in soups and sauces. They are especially beneficial in the treatment of many ailments, due to their various medicinal properties and rich iron content (Olushola, 2006 and Price, 2000) [17, 18]. In most parts of the world, the baked goods are popular food stuffs. The oats belongs to the family of poaceae and is commonly known as *Avena Sativa*. Oats have been linked to the health claims attributed to the use of β-glucans (Weightman *et al.*, 2004) [22]. It is a good source of antioxidant vitamin E (tocols), phytic acid, phenolic acid and avenantramides. Because of these reasons the present studies were carried out using *Moringa* leaf flour and oat flour.

Materials and Methods
Moringa leaves were collected from the farm of College of Food Science and Technology, Pulivendula and another ingredients wheat flour, oats flour, sugar, fat, baking powder, skim milk powder, were procured from local market in Pulivendula.

Preparation of *Moringa* leaf flour
A freshly harvested leaves were blanched in hot water and then they were dried under shade drying. The dried leaves were grinded and pass to BSS mesh size of 30 and sealed in a LDPE packaging material. The process preparation of *Moringa* leaf powder is depicted in process flow chart in Fig.1

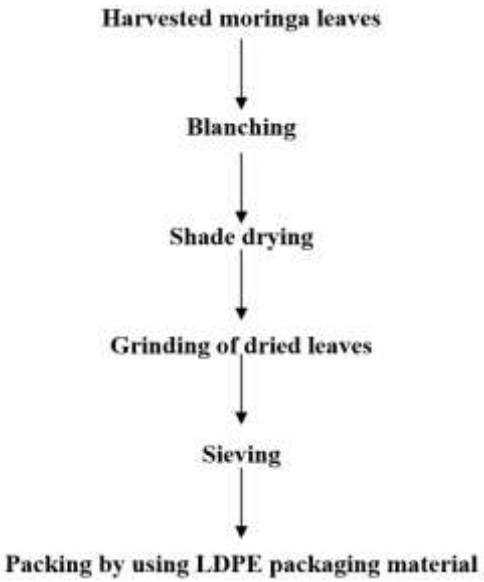


Fig 1: Preparation of *Moringa* leaf flour

Drying method

The drying method used for *Moringa* leaves is shadow drying and for this weigh 200g of *Moringa* leaves accurately for drying under shadow.

Shadow drying

In shadow drying, the air dried leaves are spread on filter paper. The room which allowed was well ventilated with natural air circulation was used for shadow drying.

Preparation of *Moringa* biscuits with various formulations

Table 1: Formulations of *Moringa* biscuits Sensory evaluation

Constituents	T_1	T_2	T_3	T_4	Control
Refined wheat flour (g)	100.5	100.5	70.5	70.5	100.5
Margarine (g)	50.5	50.5	50.5	50.5	50.5
Sugar (g)	40.5	40.5	40.5	40.5	40.5
Baking powder (g)	0.5	0.5	0.5	0.5	0.5
Oats flour (g)	-	-	30	30	-
Skim milk powder (g)	5	5	5	5	5
Moringa flour (g)	3	5	3	5	-

Sensory evaluation method is used to evaluate the biscuits made from *Moringa* leaf flour. Unskilled panel members of twenty five members were chosen from the College of Food Science and Technology. A nine (9) point hedonic scales with rating ranging from 1 which is dislike extremely to 9 like extremely, appearance, color, texture, flavour, sweetness and overall acceptability were the attributes selected for the evaluation of biscuits.

Colour

Hunter developed one of the most successful tri-colometric system for measuring food colours. Tristimulus amber, green and blue filters together with selected photocells metering circuits provide close approximations of the 'x', 'y' and 'z' functions of the CIE system. In the hunter system, colours are located in a colour space which is not identical with the CIE colour space, but it is related to it. The chromaticity plan is defined by dimensions 'a' and 'b'. The white point is at the origin. The hunter positive 'a' values indicate redness and negative 'a' values indicate greenness. The hunter positive 'b' values indicate yellowness and negative 'b' values blueness. The 'a' values are functions of 'x' and 'y' and 'b' values those of 'z' and 'y'. For particular colour hue or dominant wavelength is given by the ratio a/b or by one of the angels ɵ = tan-1(a/b) or tan-1(b/a). The saturation is given by the distance from the color point 'C' to the white point which is $\sqrt{(a^2+b^2)}$. The hunter Rd (diffuse reflectance) or with a different circuit in the instrument, visual lightness (L) in perceptibility units, are directly comparable to the 'y' of the CIE system or value of the munsell system. The 'a' and 'b' value will be different according to the circuit used and they may be designated aRd, bRd, or aL, bL.

Hunter values may be used to calculate the total color difference (ΔE) between a sample and a standard in visual perceptibility units.

$$\Delta E = \sqrt{[(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2]}$$

Results and Discussion

Drying methods of *Moringa* leaves

We observed the reduction in moisture content in solar drying and shadow drying of *Moringa* leaves as shown in Table 2 and Fig.3. Shadow drying is suitable for drying of *Moringa* leaves because retention of colour and nutrients in the leaves. The initial moisture content was found 320g at both solar and shadow drying methods and the final moisture content was found 50g (solar drying) and 60g (shadow drying) at 5.30 p.m. with the temperatures and relative humidities 35 °C, 33 °C, 53 per cent and 55 per cent, respectively.

Table 2: Reduction in moisture content of *Moringa* leaves

Time (hours)	Solar drying (g)	Shadow drying (g)
12.30 PM	320	320
1:30 PM	124	190
2:30 PM	76	136
3:30 PM	56	96
4:30 PM	50	74
5:30 PM	50	60

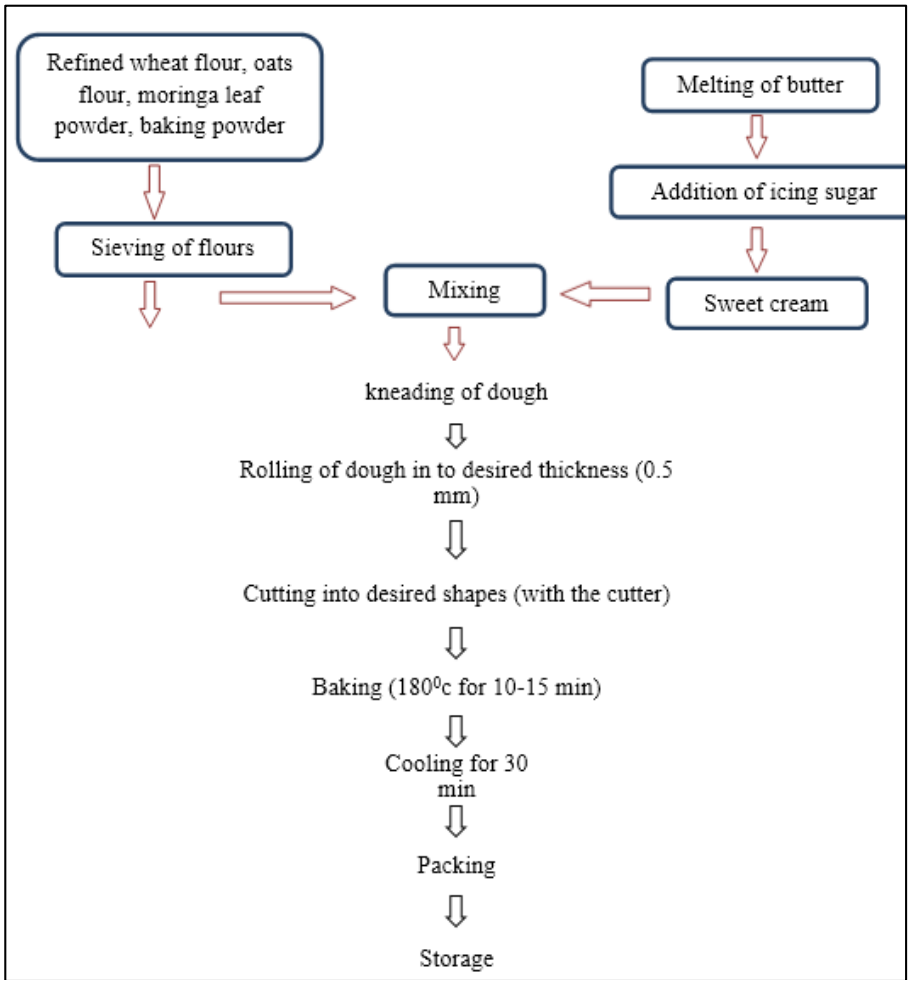


Fig 2: Flow chart of *Moringa* biscuit preparation process

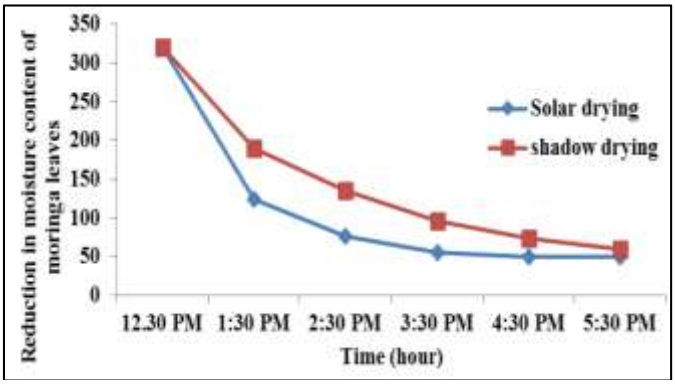


Fig 3: Reduction in moisture content of *Moringa* leaves

Effect of drying temperature and relative humidity on *Moringa* leaves during drying period of both inside the solar dryer as compared to shadow drying

The effect of drying temperature and relative humidity on drying of *Moringa* leaves at different methods of drying is shown in Table 3 and Figs. 4 and 5.

The highest temperature was found at 2.30 p.m. (47°C) with 57 per cent relative humidity when the sample dried inside the solar dryer whereas the constant temperature was found from 1.30 p.m. to 4.30 p.m. (33°C) with variations in relative humidity from 54 to 57 per cent during the shadow drying.

Table 3: Observations on drying temperature and relative humidity inside the solar dryer as compared to shadow drying during drying period of *Moringa* leaves

Time (hours)	Drying Temperature (°C)		Relative humidity (%)	
	Solar drying	Shadow drying	Solar drying	Shadow drying
12.30 p.m.	38	30	58	60
1:30 p.m.	46	33	57	59
2:30 p.m.	47	33	57	59
3:30 p.m.	45	33	54	57
4:30 p.m.	43	33	54	55
5:30 p.m.	35	32	53	55

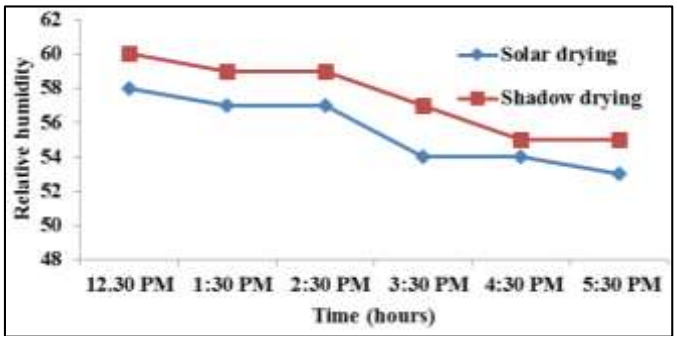


Fig 4: Relative humidity in shadow drying and solar drying

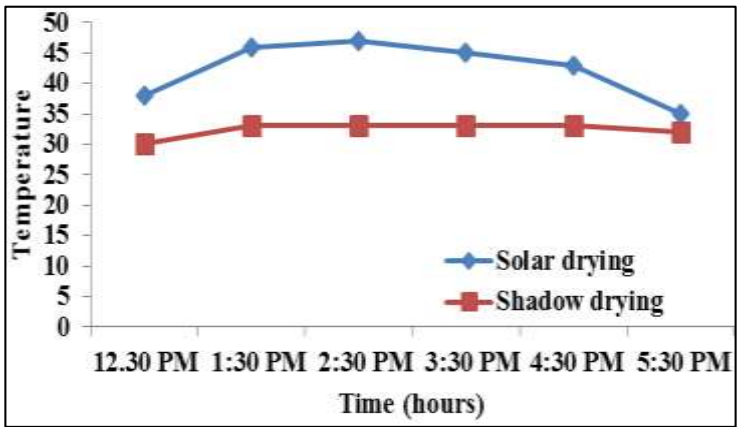


Fig 5: Observations of temperature in shadow drying and solar drying

Colour determination

The colour values of *Moringa* biscuits for different samples are depicted (Table 4 and Fig. 6) the highest *L** value was found in the control (72.06) and in the treatment T_2 (49.83) followed by T_1 (49.76), T_3 (48.89) and T_4 (45.89). The *a** value for different T_1 (-1.48), T_2 (-3.62), T_3 (-2.07), T_4 (-2.07). The highest values was noticed in control (-1.07) followed by sample T_2 (-1.48). The b*value for different sample T_1 (29.24), sample T_2 (30.21), sample T_3 (29.02), sample T_4 (30.34), control (24.47). The highest b*value was recorded in sample T_3 (30.34) followed by sample T_2 (30.21).

Table 4: Colour values of *Moringa* biscuits with different treatments

Samples	L*	a*	b*
Control	72.06	-1.07	24.47
T_1	49.76	-1.48	29.24
T_2	49.83	-3.62	30.21
T_3	48.25	-1.85	29.02
T_4	45.89	-2.07	30.34

Where,

T_1= 3 g *Moringa* leaf powder

T_2 = 5 g *Moringa* leaf powder

T_3 = 3 g *Moringa* leaf powder with oats flour

T_4 = 5 g *Moringa* leaf powder with oats flour

L* = lightness to darkness

a* = redness to greenness

b* = yellowness to blueness

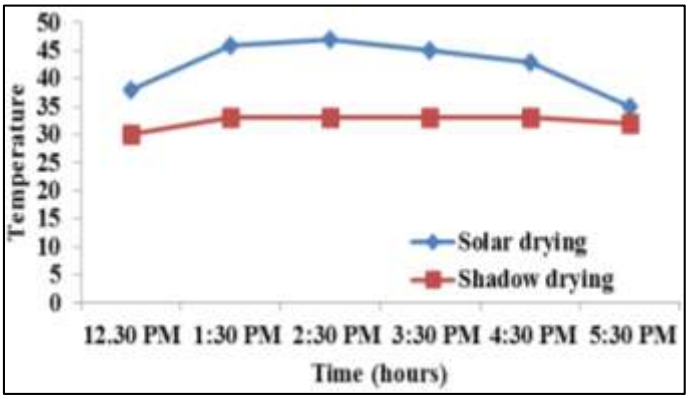
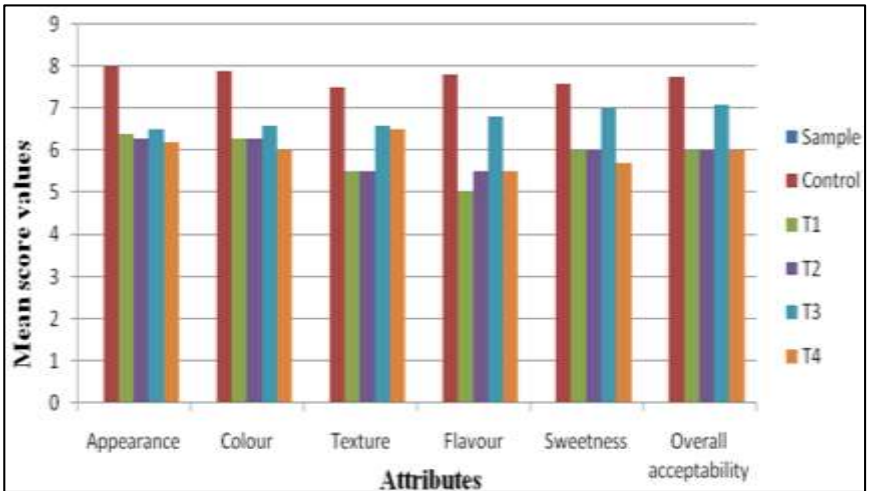


Fig 6: Graphical representation of colour determination in *Moringa* biscuits

Sensory characteristics of *Moringa* Biscuits

The sensory characteristics like appearance, colour, texture, flavor, sweetness and overall acceptability of treatment T_3 was found highest score *viz.*, appearance (6.5), colour (6.6), texture (6.6), flavor (6.8), sweetness (7.0) and overall acceptability (7.1) than other treatments. T_3 had retained the highly acceptable sensory properties than T_1, T_2 and T_4 including the control.



T_1- 3g *Moringa* leaf powder

T_2- 5g *Moringa* leaf powder

T_3,-3g *Moringa* leaf powder with oats flour

T_4- 5g *Moringa* leaf powder with oats flour

Fig 7: Graphic representation of sensory evaluation of *Moringa* biscuits

Conclusion

The *Moringa* leaves can be readily selected and utilized as a remarkable food ingredient to formulate a wide range of products considering its valuable nutrient composition with noticeable amount of both macronutrients (protein, desired fatty acid) and micronutrients (minerals and antioxidants). It can be conclude that biscuits prepared by using the *Moringa* leaf flour impart colour and flavour. These biscuits are rich in calcium and iron. The biscuits obtained by adding 1.5% *Moringa* leaf flour and oats flour (T_3) was found best formulation compared to other formulations.

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