Sesame meal and *Moringa oleifera* leaves Ready to cook curry mix: An Ethnic food of Godavari districts in Andhra Pradesh, India

Abstract:

Sesame meal was widely consumed in Godavari districts of Andhra Pradesh, India which was not known to most of the people and under-utilized. *Moringa* leaves were another nutritious food that is also under-utilized and not available in urban areas. The aim of this work was to develop the sesame meal and dried Moringa leaves as a ready to cook curry mix by assessing the ratio of sesame meal and dried *Moringa* leaves as to determine the best closer fresh leaves and sesame meal blend. The *Moringa* leaves treated with citric acid, and potassium meta bisulphite to retain the colour and dried by different techniques shade drying, solar drying and drying in Ezidri food dehydrator at 60, 50, 35 ^{o}C. The leaves dried in Ezidri food dehydrator retained more colour and nutrients. The dried leaves were used to prepare curry with sesame meal taking fresh leaves as a control in the ratio 1:2. The dried leaves and sesame meal were taken in the ratio 0.1:1, 0.12:1 and 0.14:1, prepared samples were evaluated for sensory characteristics and compared with the control sample. The curry prepared in the ratio 0.12:1 is best accepted and close to the control sample. The nutritive value shows Sesame meal and *Moringa* leaves were the best cheapest sources of protein, calcium, iron, potassium and vitamin A.

Keywords:

Drying; Sensory; Nutrition; Oil seed; Protein

Introduction:

Sesame (*Sesamum indicum*) is an annual and one of the oldest oilseed crops of the world. It is said to be native to India though its origin is sometimes traced to Central Africa and sometimes to Indonesia. History says that while creating the world Gods drank wine made from sesame seeds. According to Hindu mythology, sesame seeds were first originated in India and considered as the symbol of immortality (Baptista De Carvalho et al., 2001). Sesame seeds were the first oldest condiment dating around 1600 BC known to man. Sesame is the first oil crop processed for oil. Chinese used sesame oil as a remedy for toothaches and gum diseases during the 4th century. The famous phrase from Arabian Nights “Open Sesame” denotes the bursting nature of the sesame pod at maturity. The pods are 3 mm long, flat and oval. The colour of seeds varies from beige or creamy white when husked. Sesame oil is one of the most important oils of domestic consumption in India. India is the largest producer of Sesame accounting for 36 percent of the world’s production grown in almost all parts of the country (Suja et al., 2004). It is called ‘queen of oils seed crops’ because of the high yield of oil. As per FAO statistics 2017, the sesame is harvested 18, 00, 000-hectare area and production is 7, 51, 000 tonnes in India. Sesame oil is used as an antibacterial mouth wash, to relieve anxiety and insomnia. Sesame oil is resistant to rancidity and highly stable. It is composed of 14 % saturated, 39 % monounsaturated and 46 % polyunsaturated fatty acids. The oil is also effective in treating nasal mucosal dryness (Johnsen et al., 2001). The sesame oil also contains linoleate in triglyceride inhibits melanoma growth. Sesame is composed of 3.2 % glucose, 2.6 % fructose and 0.2 % sucrose. Sesamin and sesamolin two components of sesame seeds convert into phenolic antioxidants sesamol and sesaminol. These compounds are lignans with cholesterol-lowering effect, prevent high blood pressure and increase vitamin E absorption. Cephalin present in sesame has haemostatic activity. The fibre in sesame is used as antidiabetic, antitumor, antiulcer, cancer preventive cardio protective and laxative (Hirata et al., 1996). Sesame is excellent source of copper and calcium helps in bone strengthening and meets the RDA requirement. Sesame is one of the important diets for adult females to meet their calcium requirement. Sesame meal is one of the most commonly used material for cattle and poultry feed and highly underutilized for human consumption. The consumption of sesame meal is restricted only to the East and West Godavari districts of Andhra Pradesh, India. In the two districts, sesame meal is consumed as a traditional food in the form of curry along with rice or chapati. The new-born babies will be fed with sesame meal as their first solid food after the milk traditionally due to its high protein and calcium content. Consumption of sesame meal increase milk in lactating mother (Dimitrov et al., 2003). The meal is considered as waste from the oil industry and used only as animal feed in the remaining parts of the world. The curry made with sesame meal and moringa leaves in the ratio of 2:1 traditionally along with other spices and seasonings.

Moringa oleifera is the most common species cultivated around the world with wide health benefits. *Moringa* leaves are one of the rich sources of Vitamin A, Vitamin C, iron, potassium, calcium and phosphorous. The phytochemicals of *Moringa* leaves have anticancer and hypotensive properties. *Moringa* extracts have potential antimicrobial activity and inhibit *Staphylococcus aureus* in food and animal intestines and the best substitute for antibiotics (Commonwealth Forestry Association, 1970). The leaves are rich in protein content and have good quality with all essential amino acids. The fat is highly unsaturated and good for heart and phytochemicals prevent the valves and blood vessel blocks (Yang et al., 2006). But the main drawback is the leaves with the high moisture content of up to 72% which makes them highly perishable. To enhance shelf life drying is one of the best cost-effective methods to reduce the moisture and lower the water activity. Drying is one of the most common and oldest method of preservation technique. *Moringa* leaves are also not easily available in urban areas. Therefore, the main objective of the present work is to develop the Sesame meal and Moringa leaves as a Ready to cook curry mix, to determine the best acceptable ratio of sesame meal and dried moringa leaves for curry preparation and to determine the best blend closer to the fresh leaves and sesame meal blend.

Materials and Methods:

Raw materials:

Sesame meal obtained from deoiled sesame meal from solvent extraction was procured from Samarlakota, Andhra Pradesh, India. Moringa leaves are plucked freshly from the tree every time before conducting the experiments. Additives like Sodium chloride, Potassium meta bisulphite are of food-grade and procured from the local market of Bapatla, Andhra Pradesh, India.

Sesame meal:

Sesame meal of each 100 g weight is packed in food-grade polypropylene pouch and vacuum packed. Fig. 1 shows the vacuum packing and packed samples of sesame meal. The packed meal is stored at room temperature throughout the study.

Drying the leaves treated with Sodium chloride and Potassium meta bisulphite:

Moringa leaves are plucked, separated from the stalks and washed with clean water to remove all the dust. The washed leaves were blanched in 2% Sodium chloride at 80 ^{o}C for one minute and transferred immediately into the cold water at 2 ^{o}C containing 1200 ppm Potassium meta bisulphite (maximum limit as per FSSAI standards). After two minutes' water is drained off and the surface moisture is removed by wiping with a cloth. The leaves were then spread on the trays at 2 mm thickness and kept for drying.

Different drying techniques were followed. Leaves were dried in a solar dryer at an average temperature of 39.86 ^{o}C inside the dryer and an average outside temperature of 26.5 ^{o}C and average relative humidity of 41.5% inside the dryer and average relative humidity of 41.07% outside the dryer. The temperature was monitored continuously using a thermocouple and relative humidity with a hygrometer. Another batch of leaves was kept for shade drying at room temperature.

A batch of leaves was dried in Ezidri FD500 food dehydrator manufacture by Hydro flow industries, New Zealand at three different temperatures of 35, 50 and 60 ^{o}C. The Ezidri food dehydrator has airflow pattern with a microprocessor and integrated PLD circuitries accurate airflow temperature and exceptional expandability. These features ensure fast, even drying with no tray rotation or loss of nutritional value. The dried leaves were then packed in food grade polypropylene pouches and kept for storage at room temperature.

Drying the leaves treated with Citric acid:

The freshly plucked Moringa leaves were washed and blanched in 1% citric acid for 1 minute at 80 ^{o}C. The blanched leaves were transferred immediately into cold water at 2 ^{o}C and left for 2 minutes. The surface water is wiped off and leaves were dried in the solar drier at an average temperature of 40.43 ^{o}C inside the solar dryer and 26.52 ^{o}C of outside temperature and average relative humidity of 41.5% inside the solar dryer and average relative humidity of 41.07% outside the dryer.

Fig. 2 shows the pictorial flow chart of the procedure followed for drying of *Moringa* leaves by different methods.

Preparation of curry with Sesame meal and Moringa leaves:

Curry was prepared with Moringa leaves by taking fresh leaves as control and dehydrated leaves as test samples to know the much-accepted proportion of leaves and sesame and close to fresh sample. The leaves dried in a food dehydrator at 50 ^{o}C having better colour retention were used for curry preparation. A pan was placed on the stove and oil is added. After oil gets heated spices, onions and chilies were added and cooked. Then Moringa leaves, salt and turmeric were added and cooked. Water is added and then sesame meal and the pan was closed with a lid and allowed to cook for 1 to 2 minutes and serve. Curry made with fresh leaves to sesame meal in proportion 1:2 is taken as control which is traditionally much acceptable. Test samples of curry are made with dehydrated *Moringa* leaves and sesame meal in the proportions of 0.1:1 (P1), 0.12:1 (P2) and 0.14:1 (P3). The curry samples prepared in different proportions were shown in Fig. 3.

Sensory evaluation:

The curry prepared was evaluated for colour, appearance, taste, flavour, texture of meal, texture of leaf by 15 semi-trained panel members using a 9-point hedonic scale, 9 for like extremely to 1 for dislike extremely (Wichchukit and O'Mahony, 2015). The average of all the scores of sensory characters was expressed as overall acceptability.

Evaluation of the nutritive value of Sesame meal and *Moringa* leaves:

The biochemical analysis was done to evaluate the nutritive value of Sesame meal and Moringa leaves. The analysis was done as per the Official methods of analysis, 2000 Association of Official Analytical Chemists, Washington D. C (Horwitz, 2000).

Sesame meal was evaluated for moisture, carbohydrate, protein, fat, ash, calcium and phosphorous content. Moringa leaves were evaluated for moisture, carbohydrate, protein, fat, ash, crude fibre, calcium, phosphorous, magnesium, iron and vitamin A content. Moisture content was measured by hot air oven AOAC 930.15 method, total carbohydrate by phenol sulphuric acid AOAC 988.12 method, fat by soxhlet method AOAC 945.16, protein by Kjeldahl AOAC 920.87 method taking 5.35 as conversion factor for Sesame meal and 6.25 for Moringa, crude fibre by gravimetric AOAC 945.18 method, ash by muffle furnace AOAC 942.05 method, calcium by titrimetric AOAC 968.31 method, magnesium AOAC 980.03, phosphorous AOAC 970.39, iron and Vitamin A AOAC 974.29 method.

Statistical analysis:

The experiments were conducted in triplicates and statistical analysis was done by ANOVA using IBM SPSS version 25.0 software. The means were considered significant if $p \leq 0.05$. Sensory data were analysed by Principal component analysis using XLSTAT 2018.1 49320 version software.

Results and Discussion:

Drying the leaves by treating with Sodium chloride and Potassium meta bisulphite:

The leaves were blanched in 2% Sodium chloride at 80 ^{o}C for 1 minute to inactivate all the enzymes and microorganisms. Blanched leaves were transferred to cold water at 2 ^{o}C containing 1200 ppm Potassium meta bisulphite to preserve the texture and colour of the leaves. The leaves dried in shade at room temperature, solar dryer and Ezidri FD500 food dehydrator. The leaves were dried to 7.6 ± 0.04 % moisture content below which the leaves were becoming darker, which were unacceptable for leaf quality and consumption.

The green colour retention is more in the leaves dried in Ezidri food dehydrator at 50 ^{o}C followed by the leaves dried at 60 ^{o}C then leaves dried at 35 ^{o}C and then leaves dried in a solar dryer. The leaves dried in the solar dryer and Ezidri food dehydrator at 35 ^{o}C took a longer time for drying and darker which may be due to the degradation of chlorophyll during exposure of leaves to heat for a long time. The leaves dried at 60 ^{o}C were also darker which may due to the degradation of chlorophyll (Negi and Roy, 2000).

Drying the leaves treated with Citric acid:

The *Moringa* leaves when blanched with 1% citric acid, the leaves immediately turned to yellow colour and became darker after drying. This colour change is may be due to the degradation of chlorophyll by the acid. The colour of the leaves is unacceptable for consumption (Koca et al., 2007). The leaves samples dried by different methods were shown in Fig. 4. As the leaves were very thin and sensitive, the chlorophyll may be damaged immediately and citric acid treatment cannot be used for treating the leaves.

Sensory evaluation:

Sensory evaluation was conducted and the average scores for the samples given by panel members were shown in Table 1. The highest overall acceptability was found for the control sample made with fresh leaves. Scores of sample P2 are closer to the control sample, there is no significant difference between two samples in all attributes except texture of leaf. P2 and P3 samples are significantly different from each other and also with control and P2 samples in all attributes. The results were represented in the form of a web graph shown in Fig. 5. The data collected by sensory evaluation were processed by principal component analysis. The first two components F1 and F2 explained 99.72% of the total variance of which 96.89% for F1 and 2.83% for F2 (Fig. 6). Based on the positions of the samples in the quadrants, it can be concluded that the control sample in the first quadrant is highly acceptable followed by P2 in the second quadrant and P1 and P3 is least acceptable. Sensory attributes colour, flavour, and texture of meal are closely related, taste, appearance and overall acceptability are closely related. Overall acceptability and flavour are not related to each other. Texture of leaf and texture of meal are negatively correlated.

Nutritive value of Sesame meal and Moringa leaves:

The biochemical analysis was conducted to evaluate the nutritive value of Sesame meal and *Moringa* leaves. The nutritive value of the sesame meal is shown in Table 2. The sesame meal is a rich source of protein with about 42.47g per 100g followed by carbohydrate with 34.88g. It is also a rich source of calcium with 152.23mg. The results were similar to the values given by Hasan and Khandaker (2000) and I.S.I. (1961) (Dimitrov et al., 2003). The sesame meal was the best alternative source of protein (El Tinay et al., 1976) to meat for vegetarians and highly palatable when consumed with rice or chapati. Sesame is also a good source of tocopherol, phytosterol and polyphenols help in controlling weight gain, prevents cardiovascular diseases, cancer and helps in anti-aging (Smith and Salerno, 1992). The stability of sesame meal during storage is very high due to its low-fat content and phytochemicals help to prevent the oxidation (Quasem et al., 2009). The shelf life of sesame meal is also very high and can stay for more than 4 months at room temperature.

Traditionally sesame meal is stored by adding salt to it and stored up to nine months. The sesame meal is the best food material in terms of nutritive value and also shelf-stable product and very cheap source. It is one of the best cheap sources of protein, which is underutilized and not known to most people. Middle and low-income people sometimes could not afford high-cost vegetables during off-season and low production, could not afford high protein foods like meat. In such cases, sesame meal is the best alternative and cheapest source of protein. Sesame meal can also be stored easily for a long time.

Table 3 shows the nutritive value of fresh and dried *Moringa* leaves. The moisture content of fresh leaves is about 72.31 ± 2.04g per 100g. The leaves were dried to a moisture content of 7.6 ± 0.04 %. The increase in the nutritive value of the dried leaves is due to the concentration of nutrients due to the loss of moisture. The carbohydrate content is significantly low in leaves dried in a food dehydrator at 60 ^{o}C than other samples and there is no significant difference between the other three samples. The protein content was maximum in leaves dried at 35 ^{o}C followed by 60 and 50 ^{o}C and least in solar dried samples. The low protein may be due to Millard's reaction at high temperature as the drying time is more in the solar dryer when compared to others (Clement et al., 2017). The Vitamin A content is maximum in leaves dried at 50 ^{o}C followed by samples dried at 35^{o} C and least found in the solar dried sample. There is a significant difference between the four dried samples. Overall, there is no large difference in the nutritive value of four samples but best retained in the leaves dried at 50 ^{o}C. The leaves dried at 50 ^{O}C has the better colour and nutritive value retention and can be used for culinary purpose. Similar results were found by Joshi and Mehta, 2010**.** The *Moringa* leaves are well known plant based food material with high antioxidant activity and rich in phytochemicals responsible for various health benefits like antioxidant, cardio protective, cancer preventive, protect from microbial infections and protects from brain diseases. The leaves are rich with Vitamin A concentrations more than carrot, potassium more than banana and rich with iron meets the RDA of the body and protects from anaemia.

Overall, the combination of Sesame meal and *Moringa* leaves will be the best and cheapest sources of food materials with all the vital nutrients providing about 44.12g protein, 37.26 carbohydrate, 3.4g crude fiber per 100g of curry mix. The nutrients like calcium, iron, potassium, vitamin A will meet the RDA requirement of the body and protects from many diseases and infections. The Sesame meal *Moringa* leaves curry mix will be commercially feasible and can be made available in urban areas where people require a healthy diet for the present day modern lifestyle and can also be a "poor people's rich food". The cooking process is also very easy and helpful in rushing situations and emergencies like natural calamities during which people can't go out to buy vegetables.

Conclusion:

By-product of the Sesame oil industry deoiled meal is the traditional ethnic food of Godavari districts of Andhra Pradesh, India. It is the highly nutritive but under-utilized product not known to people and used as animal feed in remaining places. The protein concentrates and isolates are extracted from the meal but it is a costly process. *Moringa* leaves are highly nutritive leafy vegetables which were also not commonly consumed by people. Many nutrient extract products from *Moringa* leaves are available in the market which are costly and cannot afford by low and middle income people. *Moringa* leaves cannot be available in urban areas. The dried *Moringa* leaves was the best alternative and cheaper form makes the leaves available in urban areas and can be available at affordable prices. Dried fenugreek leaves are available already in the market. The study shows the utilization of highly nutritive under-utilized food products in a cheaper form. The detailed shelf-life studies for both are yet to be conducted, but traditionally sesame meal is known to be highly shelf-stable product up to nine months with just by the addition of salt as a preservative. The fenugreek leaves available in the market with similar moisture content to *Moringa* leaves in this study have shelf life for more than four months. The study indicates ready to cook Sesame meal and *Moringa* leaves curry mix is a feasible cheaper nutritive product for modern urban people.

Competing interests:

Authors have declared that no competing interests exist.

References:

Baptista De Carvalho, P.G., Borghetti, F., Buckeridge, M.S., Morhy, L. and Ferreira Filho, E.X. (2001), "Temperature-dependent germination and endo-β- mannanase activity in sesame seeds", *Revista Brasileira de Fisiologia Vegetal*, Vol. 13 No. 2, pp. 139–148.

Clement, A., Olatunde, M., Patrick, O. and Joyce, O. (2017), "Effect of Drying Temperature on Nutritional Content of Moringa Oleifera Leave", *World Journal of Food Science and Technology*, Vol. 1 No. 311, pp. 93–96.

Commonwealth Forestry Association. (1970), "Nutrient Content of Moringa", *Echo Research Notes Vol 1*, Vol. 49 No. 2, pp. 130–134.

Dimitrov, T.Z., Georgieva, L. and Vassilev, S. (2003), "Estudio de pigmentos cerámicos del sistema ZrO_2-SiO_2-Fe_2O_3", *Boletín de La Sociedad Española de Cerámica y Vidrio*, Vol. 42 No. 4, pp. 235–237.

Hirata, F., Fujita, K., Ishikura, Y., Hosoda, K., Ishikawa, T. and Nakamura, H. (1996), "Hypocholesterolemic effect of sesame lignan in humans [1]", *Atherosclerosis*, Vol. 122 No. 1, pp. 135–136.

Horwitz, W. (2000), *Official Methods of Analysis of AOAC International*, AOAC International, Gaithersburg, Md.

Johnsen, J., Bratt, B.M., Michel-Barron, O., Glennow, C. and Petruson, B. (2001), "Pure sesame oil vs isotonic sodium chloride solution as treatment for dry nasal mucosa", *Archives of Otolaryngology - Head and Neck Surgery*, Vol. 127 No. 11, pp. 1353–1356.

Joshi, P. and Mehta, D. (2010), "Effect of dehydration on the nutritive value of drumstick leaves", *Journal of Metabolomics and Systems Biology*, Vol. 1 No. 1, pp. 5–9.

Koca, N., Karadeniz, F. and Burdurlu, H.S. (2007), "Effect of pH on chlorophyll degradation and colour loss in blanched green peas", *Food Chemistry*, Vol. 100 No. 2, pp. 609–615.

Negi, P.S. and Roy, S.K. (2000), "Effect of Blanching and Drying Methods on β -Carotene, Ascorbic acid and Chlorophyll Retention of Leafy Vegetables", *LWT - Food Science and Technology*, Vol. 33 No. 4, pp. 295–298.

Quasem, J.M., Mazahreh, A.S. and Abu-Alruz, K. (2009), "Development of vegetable based milk from decorticated sesame (Sesamum Indicum)", *American Journal of Applied Sciences*, Vol. 6 No. 5, pp. 888–896.

Smith, D.E. and Salerno, J.W. (1992), "Selective growth inhibition of a human malignant melanoma cell line by sesame oil in vitro", *Prostaglandins, Leukotrienes and Essential Fatty Acids*, Vol. 46 No. 2, pp. 145–150.

Suja, K.P., Abraham, J.T., Thamizh, S.N., Jayalekshmy, A. and Arumughan, C. (2004), "Antioxidant efficacy of sesame cake extract in vegetable oil protection", *Food Chemistry*, Vol. 84 No. 3, pp. 393–400.

El Tinay, A.H., Khattab, A.H. and Khidir, M.O. (1976), "Protein and oil compositions of sesame seed", *Journal of the American Oil Chemists' Society*, Vol. 53 No. 10, pp. 648–653.

Wichchukit, S. and O'Mahony, M. (2015), "The 9-point hedonic scale and hedonic ranking in food science: Some reappraisals and alternatives", *Journal of the Science of Food and*

Agriculture, Vol. 95 No. 11, pp. 2167–2178.

Yang, R., Chang, L., Hsu, C., Weng, B., Palada, M., Chadha, M. and Levasseur, V. (2006), "Nutritional and functional properties of Moringa Leaves from germplasm, to plant, to food, to health. In: Moringa and Other Highly Nutritious Plant Resources: Strategies, Standards and Markets for a Better Impact on Nutrition in Africa.", *American Chemical Society*, pp. 1–9.

Table 1 Sensory evaluation scores of curry samples

Constituent	Nutrient Content
Moisture	7.2 ± 0.02g
Carbohydrate	34.88 ± 0.58g
Protein	42.47 ± 0.1g
Fat	6.2 ± 0.02g
Crude fiber	2.75 ± 0.2g
Ash	6.5 ± 0.03g
Calcium	152.23 ± 0.07mg
Phosphorous	771 ± 0.7 mg

All values are mean ± SD of three replicates

Values with different superscript on the same row differ significantly ($p < 0.05$)

Table 2 Nutritive value of Sesame meal

Sensory attributes	Control	P1	P2	P3
Color	7.60 ± 0.50^a	7.13 ± 0.35^b	7.60 ± 0.50^a	6.60 ± 0.50^c
Appearance	7.73 ± 0.45^a	7.06 ± 0.45^b	7.67 ± 0.61^a	6.46 ± 0.51^c
Taste	7.80 ± 0.41^a	7.13 ± 0.51^b	7.80 ± 0.41^a	6.67 ± 0.61^c
Flavor	7.67 ± 0.48^a	7.26 ± 0.45^b	7.73 ± 0.45^a	6.73 ± 0.45^c
Texture of leaf	7.86 ± 0.63^a	6.93 ± 0.45^b	7.40 ± 0.63^c	6.73 ± 0.45^b
Texture of oil meal	7.93 ± 0.59^a	7.53 ± 0.51^b	7.93 ± 0.45^a	6.80 ± 0.41^c
Overall acceptability	7.77 ± 0.36^a	7.17 ± 0.29^b	7.68 ± 0.34^a	6.67 ± 0.36^c

All values are mean ± SD of three replicates

Table 3 Nutritive value of fresh and dried *Moringa oleifera* leaves

Constituent	Fresh leaves	Leaves dehydrated in Solar dryer	Leaves dried in Food dehydrator (60 ^oC)	Leaves dried in Food dehydrator (50 ^oC)	Leaves dried in Food dehydrator (35 ^oC)
Carbohydrate (g)	14.3 ± 0.42	39.71 ± 0.35^a	39.67 ± 0.81^b	39.69 ± 0.03^a	39.41 ± 0.35^a
Protein (g)	6.49 ± 0.24	27.32 ± 0.03^a	27.37 ± 0.02^b	27.36 ± 0.01^{ab}	27.40 ± 0.02^b
Fat (g)	1.9 ± 0.14	8.36 ± 0.04^a	8.14 ± 0.02^b	8.13 ± 0.01^b	8.22 ± 0.02^c
Ash (g)	2.7 ± 0.18	6.18 ± 0.01^a	6.29 ± 0.01^b	6.28 ± 0.01^b	6.29 ± 0.01^b
Crude fiber (g)	2.3 ± 0.26	10.85 ± 0.03^a	10.92 ± 0.03^b	10.93 ± 0.01^b	11.00 ± 0.02^c
Calcium (mg)	439.6 ± 2.25	2000.67 ± 3.05^a	1995.33± 1.15^b	1990.33 ± 1.52^c	1989 ± 2.08^c
Phosphorous (mg)	66 ± 2.31	425.33 ± 2.08^a	421 ± 1.73^b	421 ± 2^b	422 ± 1.73^{ab}
Magnesium (mg)	87.86 ± 1.15	388.43 ± 0.47^a	387.33 ± 1.02^a	388.36 ± 1.03^a	388.75 ± 0.3^a
Iron (mg)	3.89 ± 0.86	36.54 ± 0.02^a	34.80 ± 0.19^b	35.68 ± 0.41^c	36.50 ± 0.02^a
Vitamin A (µg)	6651 ± 4.78	19849 ± 4.58^a	19861.67 ± 4.93^b	20519 ± 3^c	20411.33 ± 5.03^d

All values are mean ± SD of three replicates

Values with different superscript on the same row differ significantly ($p < 0.05$)

Fig. 1 Vacuum packing of Sesame meal and Packed Sesame meal samples

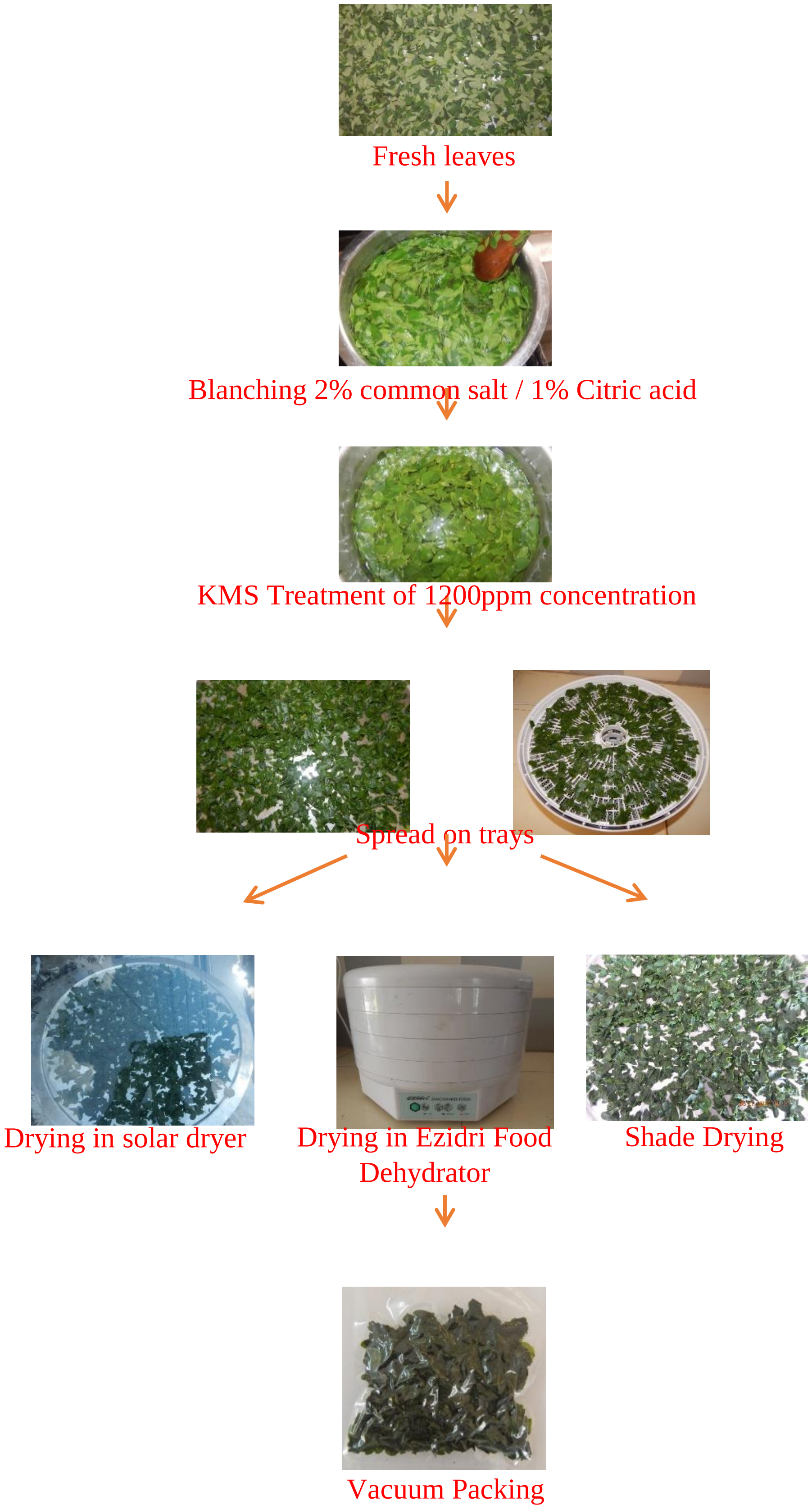

Fig. 2 Process flow chart for drying of leaves

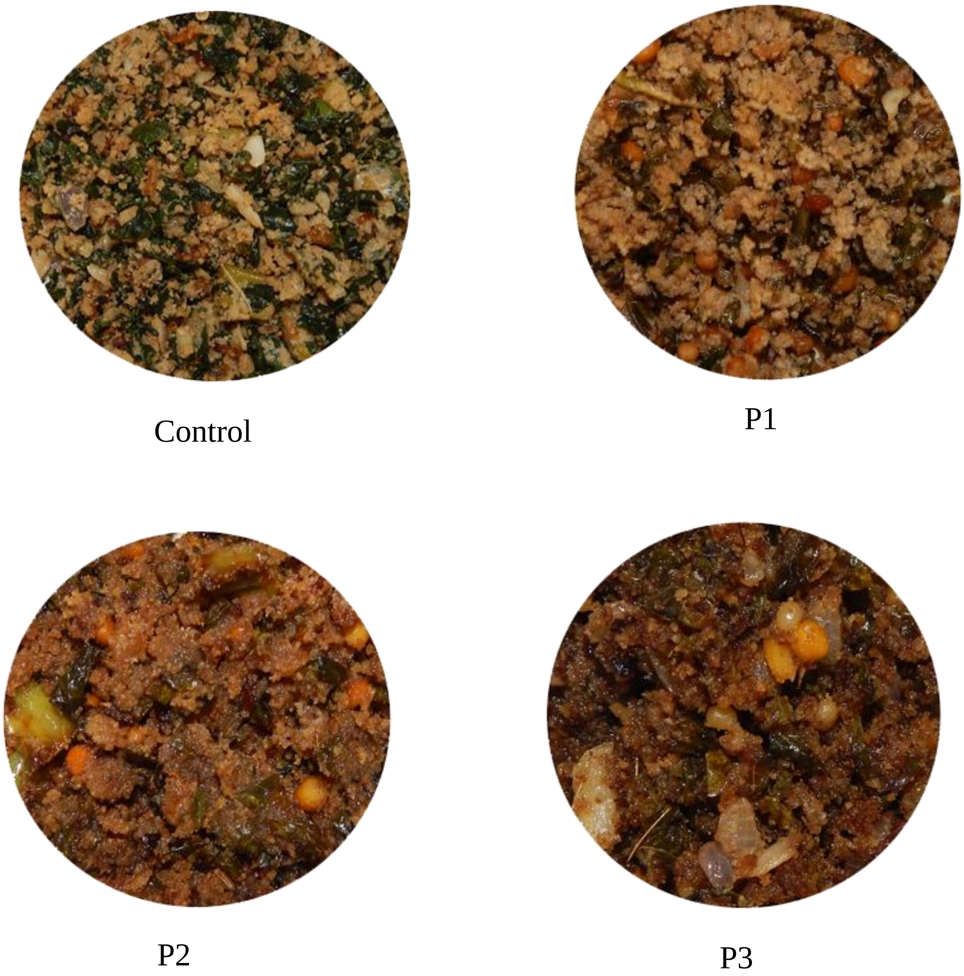

Fig. 3 Prepared curry samples of various proportions of Sesame meal to *Moringa* leaves

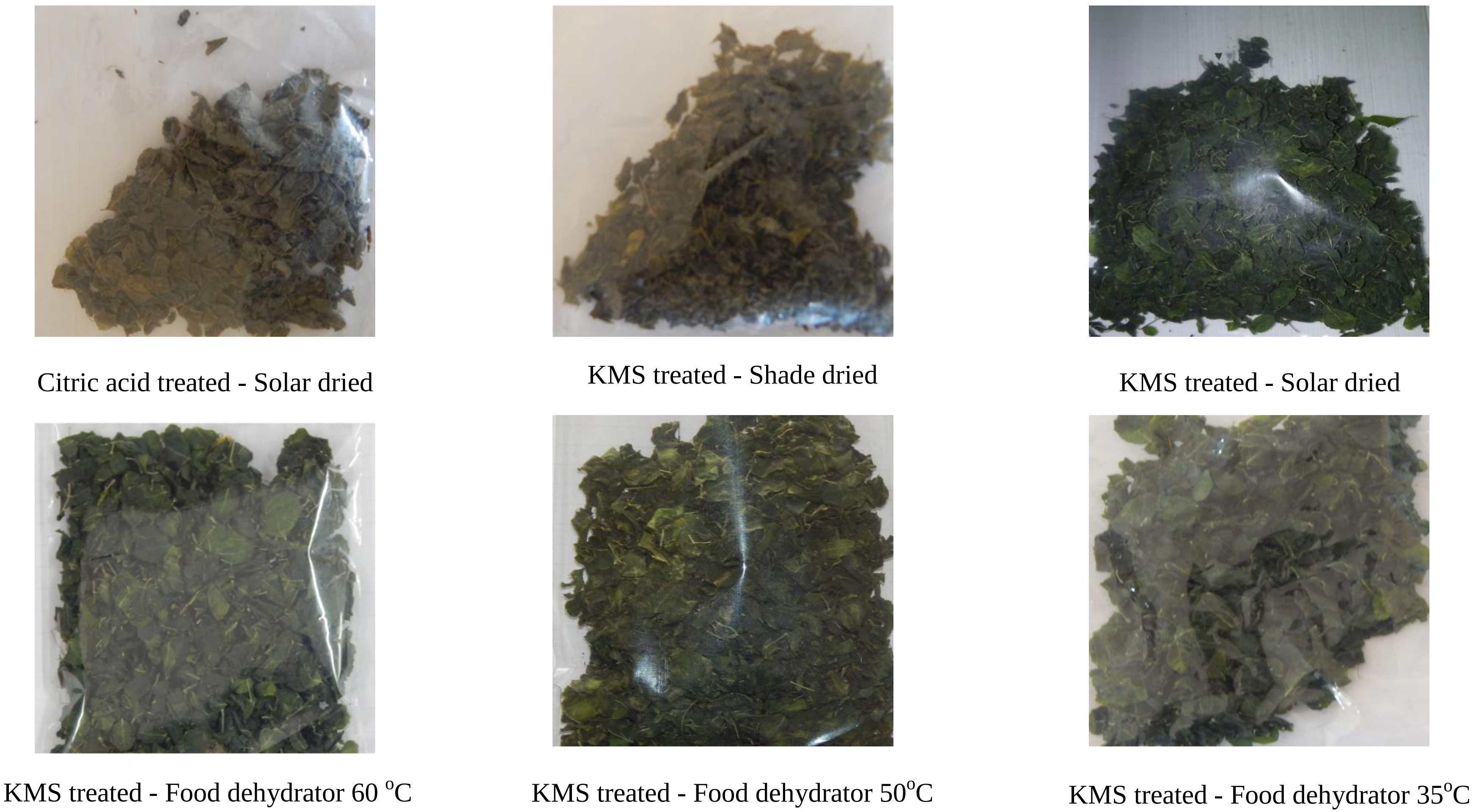

Fig. 4 Leaves samples dried by different methods

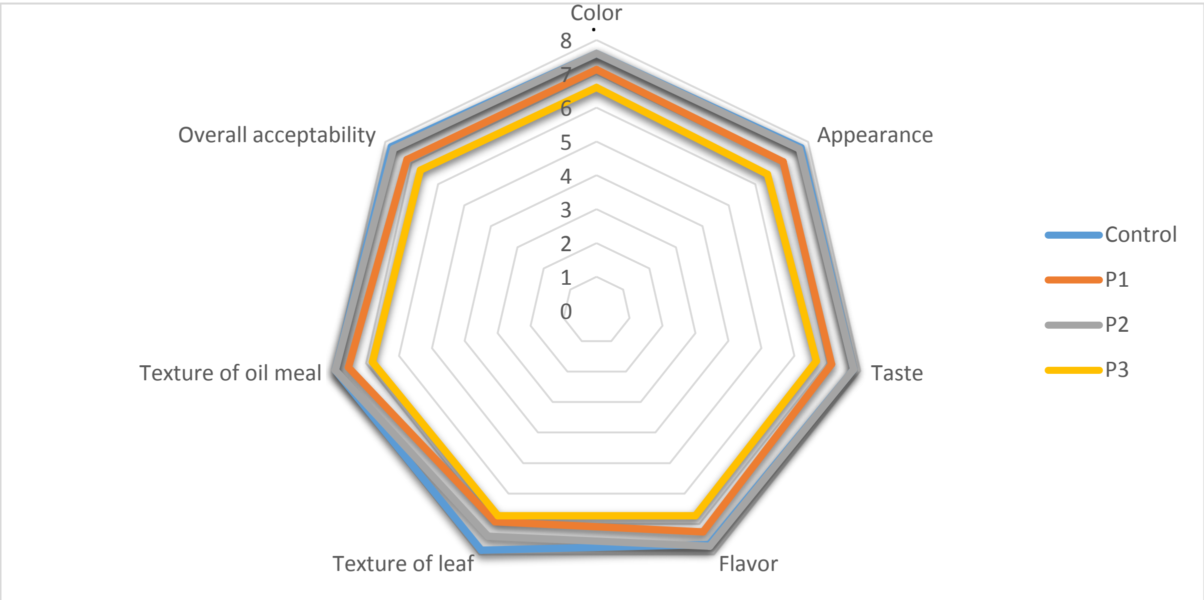

Fig. 5 Web graph showing Sensory characteristics of curry samples

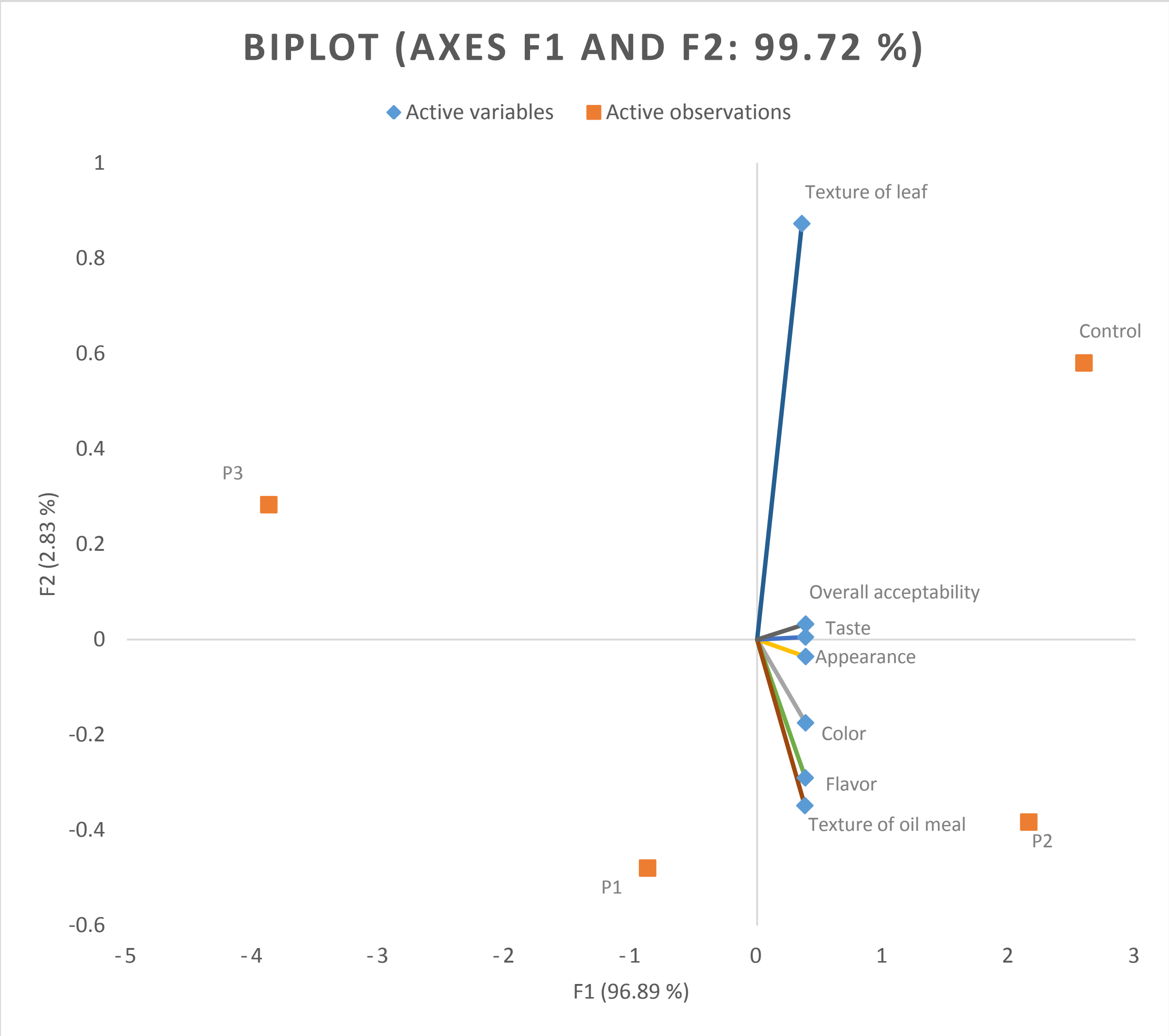

Fig. 6 Principal component analysis of sensory evaluation data