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Development of fresh *Moringa oleifera* leaf jam and its physico-chemical properties

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Abstract
The present investigation was undertaken to prepare jam using fresh apple pulp and fresh moringa leaves. To increase jam taste and nutrition, fresh moringa leaves were added at different levels. The physico-chemical properties of fresh moringa leaves jam (FMLJ) were investigated and apple jam was used as a control. Fresh moringa leaves jam (FMLJ) was produced using the traditional open pan method. The physico-chemical properties showed moisture content 29.84-41.92%, total ash 3.55-6.89%, crude protein 0.48-2.36%, total sugar 51.24-60.76%, reducing sugar 38.42-40.75%, crude fibre 0.17-2.21%, titratable acidity 0.44-0.66%, total soluble solids 68.54-70.70^{0}B and pH 3.33-4.50. There was a significant difference at ($P<0.05$) in moisture, ash, protein total sugar, reducing sugar, crude fibre, acidity, TSS and pH. The ash, protein and crude fibre showed a decreasing trained with an increasing in the level of fresh moringa leaves in the blends. The total sugar and reducing sugar of fresh moringa jam decreased with increased the level of fresh moringa leaves.

Keywords: fresh moringa leaves, chemical properties, jam, fruits and quality

1. Introduction
Jam is the product that contains fruit pulp from whole fruit or more kinds of fruit boiled with sufficient quantity of sugars at low pH (2.5-3.2) to produce a tissue with firm and gel like consistency with or without addition of water (Codex Ailamentarus, 2009) [4]. Pectin and acids are added to obtain a good quality jam with total solids and fruit accounting not less than 65% and 45% respectively. Jams are good carriers of fruit related components (sugar, fiber and other bioactive compounds) to humans finding their way during early hours on one's breakfast table. The production of apricots is limited to high altitude regions of the world with temperate temperatures that makes their processing difficult.
Moringa oleifera belonging to the family of Moringaceae is an effective remedy for malnutrition. Moringa is rich in nutritionowing to the presence of a variety of essential phyto-chemicals present in its leaves, pods and seeds. In fact, moringa is provide 7 times more vitamin C than oranges, 10 times more vitamin A than carrots, 17 times more calcium than milk,9 times more protein than yoghurt, 15 times more potassiumthan bananas and 25 times more iron than spinach (J.L. Rockwood *et al.*, 2013) [7]. The fact that moringa is easily cultivable makes it a sustainable remedy for malnutrition.
The leaves possess remarkable nutritional and medicinal qualities (Singh, S. *et al.*, 2012, Mishra, S.P. *et al.*, 2011) [18, 11]. 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; Calcium, which builds strong bones and teeth and helps prevent osteoporosis; Potassium, which is essential for the functioning of the brain and nerves, and Proteins, the basic building blocks of all our body cells. Another important point is that *Moringa* leaves contain all of the essential amino acids in a good proportion, which are the building blocks of proteins. These leaves could be a great boon to people who do not get protein from meat. *Moringa* even contains argenine and histidine
Therefore it is necessary to increase the utilization of fresh *Moringa oleifera* leaves consumption by the different communities. It should be consumed either fresh or dry. Dried leaves can be stored for a long time and can be used regularly. Many companies across the world manufacturing various products of *Moringa* leaves such as *Moringa* Tea, *Moringa* Tablets, *Moringa* Capsules, *Moringa* leaf Powder, *Moringa* Soaps and *Moringa* Face wash. Some beverages are also available in market prepared by *Moringa* leaves. So it is necessary to hygienically drying and processing of *Moringa* leaves for further uses. In this paper we have described use of fresh *Moringa* leaves into the jam for consumption purpose.

2. Materials and methods
2.1 Raw material
Fresh *Moringa oleifera* leaf (PKM-1) was procured from the department of Horticulture, Sam Higginbottom University of Agriculture Technology and Science (SHUATS), Allahabad. All the chemicals used in the present study were purchased from S.D. Fine Chemicals Ltd. Mumbai, India.

2.2 Processing of fresh moringa leaves jam (FMLJ)
Selected fresh mature apple was weighted and washed thoroughly with cold water. Cut the washed fruits with a stainless steel knife into small pieces. Pulp was prepared from apple fruit. For jam preparation First jam was prepared by using apple pulp alone, here cooking time of pulp and sugar content for jam was adjusted. Then after apple pulp was substituted with fresh moringa leaves. Different levels of fresh moringa leaves were added in the formulations of jam. For 100 grams of pulp 100 grams of sugar was taken. In the

process of standardization of ingredients (fig.1). The ratio of apple pulp to fresh moringa leaves was altered and amount of sugar were kept constant for the six samples.
Sample1- apple pulp- 100%, fresh moringa leaves- 00%
Sample2- apple pulp- 95%, fresh moringa leaves- 05%
Sample3- apple pulp- 90%, fresh moringa leaves- 10%
Sample4- apple pulp- 85%, fresh moringa leaves- 15%
Sample5- apple pulp- 80%, fresh moringa leaves- 20%
Sample6- apple pulp- 75%, fresh moringa leaves- 25%

Flow Diagram adopted for manufacturing control & experimental fruit products.

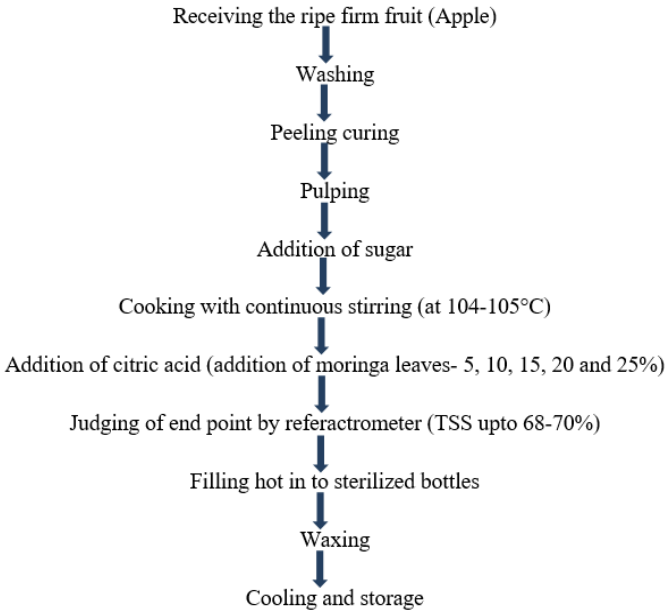

Fig 1: Flow Diagram for manufacturing control & experimental jam

2.3 *Physico-chemical properties*

At first analysis carried out for raw fruits and subsequently for processed products. Oven drying method described by the Association of Official Analytical Chemists (AOAC, 1990) [2] was used for determination of moisture content by weighing in crucible and drying in oven at 105^0C, until a constant weight was obtained. Determination of ash content was done by muffle Furness at 550^0C for 3h. The Kjeldah method was used to determine the protein content (Rangana S., 1986). Sugars by Lane and Eynon method (AOAC, 1990 and Lane JH and Eynon L., 1923) [2]. Crude fibre was determined by chemical method (AOAC, 1990) [2]. The acidity was determined by titration using standard sodium hydroxide solution and expressed as anhydrous citric acid. pH was measured by a pH meter and total soluble solids (TSS) estimated by hand referectometer.

2.4 Statistical Analysis

Results obtained from the chemical and sensory analysis were subjected analysis of variance (ANOVA) using SPSS software. The means score were separated by least significant Difference (LSD) tests. The significance were separated at $p<0.05$.

3. Results and discussion

The results of various experiments conducted during the study period are summarized below.

3.1 Physico-chemical characteristics of raw material

The composition of fresh apple pulp and fresh moringa leaves changes depending on climate, soil, region and degree of ripeness etc. The present study shows that the apple pulp and fresh moringa leaves contained percentage of moisture 86.02±9.49, 72.83±1.36; ash 1.84±1.08, 4.59±0.42; Crude protein 1.23±0.85, 5.29±0.39; Ether extract0.36±0.13, 6.72±0.31 and Crude fibre 0.17±0.77, 5.75±0.39 respectively. The percentages of moisture, proteins and fat of fresh moringa leaves were 11.9, 73.9 and 1.1%, respectively (Charles, W.Y., 2011) [11]. Through data tabulated in Table (1), it could be clearly concluded that fresh Moringa leaves are rich to great extent in many significant components such as protein and total ash.

Table 1: Chemical composition of fresh apple pulp and fresh moringa (*M. oleifera PKM-1*) leaves (n=3)

Parameters	Fresh apple pulp	Fresh moringa leaves
Moisture (%)	86.02 ± 9.49	72.83 ± 1.36
Total ash (%)	1.84 ± 1.08	4.59 ± 0.42
Crude Protein (%)	1.23 ± 0.85	5.29 ± 0.39
Titratable acidity (%)	0.67 ± 0.51	-
Ether extract (%)	0.36 ± 0.13	6.72 ± 0.31
Crude fibre (%)	0.17 ± 0.77	5.75± 0.39

3.2 Physico-chemical composition of fresh moringa leaf jam

3.2.1 Moisture content

Moisture content of different combination of fresh moringa leaf jam as determined by AOAC, 1990 [2] was found to be in the range of 29.84 to 41.92% (fig.2). Among the products studied, FMLJ-25% displayed highest moisture content (41.91%), closely followed by FMLJ-5% (40.43%), FMLJ-20 (38.89%), FMLJ-10% (35.60%) and FMLJ-15% (33.52%). FJ-C showed lowest value of moisture content 29.84%. In most of the treatment combinations moisture content differed significantly.

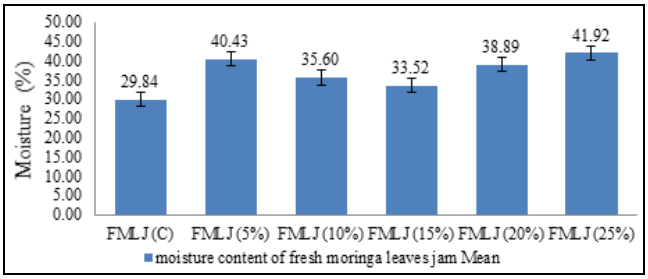

Fig 2: Moisture content of fresh moringa leaves jam

3.2.2 Total ash content

The ash value is a measure of the amount of added minerals. Natural ash content is due to the minerals like calcium, phosphorus and iron. Ash content of a foodstuff represents

inorganic residue remaining after destruction of organic matter (Ranganna, 1986) [17]. In the present study maximum total ash content was in FMLJ-25% (6.89%) followed by FMLJ-20%, FMLJ-15%, FMLJ-10%, FMLJ-05% and FJ-C (6.22, 5.66, 4.82, 3.91 and 3.55) respectively (fig.3). In most of the treatment combinations total ash content differed significantly. The ash content of about 4.59% indicates that the moringa leaves are rich in mineral elements.

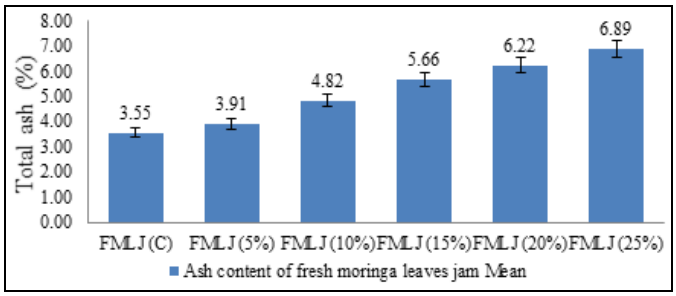

Fig 3: Total ash content of fresh moringa leaves jam

3.2.3 Crude protein content

Crude protein content of 2.36±0.08 % recorded in this study was close to the value of 3.75% reported by Ladeji and Okoye (1993). Maximum crude protein content was in FMLJ-25% (2.36%) followed by FMLJ-20%, FMLJ-15%, FMLJ-10%, FMLJ-05% and FJ-C (1.92, 1.52, 0.92, 0.67 and 0.48) respectively showed in fig.4. Crude protein differed significantly in most of the different combination of fresh moringa leaves jam. According to Charles *et al.*, 2011 [11], crude protein in fresh moringa leaves was 5.29%. Fresh M. oleifera leaves are good source of protein content.

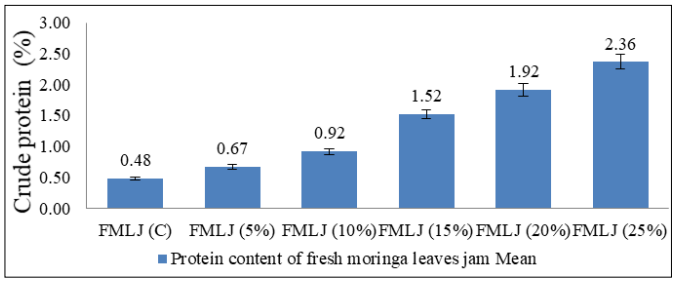

Fig 4: Crude protein content of fresh moringa leaves jam

3.2.4 Total sugars content

Total sugar of different combination of fresh moringa leaf jam as determined by titration method was found to be in the range of 60.76 to 51.24% (fig.5). Among the products studied, FMLJ-25% displayed lowest total sugar content (51.24%), closely followed by FMLJ-20% (53.72%), FMLJ-15 (55.74%), FMLJ-10% (57.52%) and FMLJ-5% (59.24%). FJ-C showed highest value of total sugar content 60.76%. In most of the treatment combinations total sugar content differed significantly. In the prepared sample FMLJ-25% displayed lowest total sugar content because in this sample maximum fresh moringa leaves were present in compared to other samples, moringa leaves are rich in fibre content. According to Reddy *et al.*, 2016, total sugar content in wood apple date jam was 65.5±5.64%.

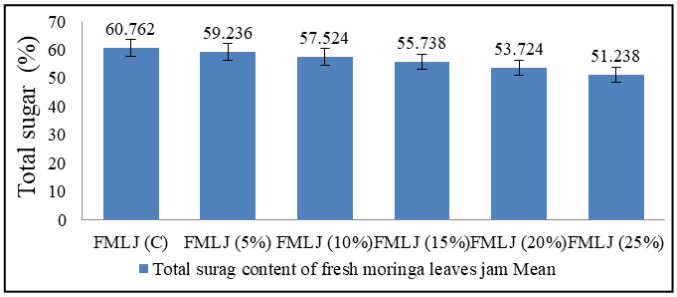

Fig 5: Total sugar content of fresh moringa leaves jam

3.2.5 Reducing sugars content

Sugars with reducing property are called reducing sugars. Maximum reducing sugar content was in FJ-C (40.75%) followed by FMLJ-05%, FMLJ-10%, FMLJ-15%, FMLJ-20% and FMLJ-25% (40.15, 39.61, 39.16, 39.11 and 38.42%) respectively (fig.6). Reducing sugar differed significantly in most of the different combination of fresh moringa leaves jam. Reducing sugar content was within the values 20-40% acceptable in commercial (Jams D.A., 2002).

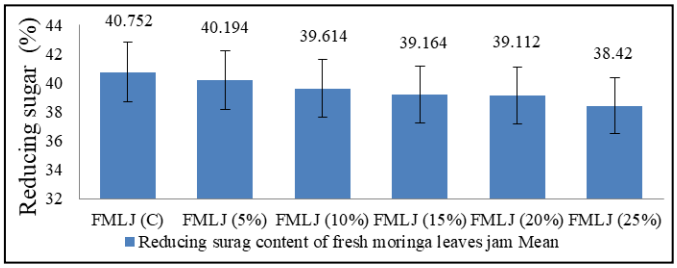

Fig 6: Reducing sugar content of fresh moringa leaves jam

3.2.6 Crude fibre content

In the present study maximum crude fibre content was in FMLJ-25% (2.21%) followed by FMLJ-20%, FMLJ-15%, FMLJ-10%, FMLJ-05% and FJ-C (1.93, 1.17, 0.56, 0.38 and 0.17%) respectively showed in fig.7. In most of the treatment combinations crude fibre content differed significantly. In the prepared sample FMLJ-25% displayed highest crude fibre content because in this sample maximum fresh moringa leaves were present in compared to other samples. According to Rajput H. *et al.*, 2017 [15], crude fibre was 5.75% in fresh moringa leaves. Moringa leaves are rich in fibre content.

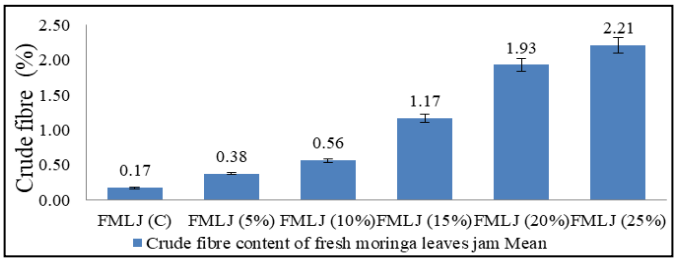

Fig 7: Crude fibre content of fresh moringa leaves jam

3.2.7 Titratable acidity

Titratable acidity studied to ensure physico-chemical changes during preparation. The titratable acidity of samples FJ-C, FMLJ-5%, FMLJ-10%, FMLJ-15%, FMLJ-20%, FMLJ-25% were 0.66, 0.51, 0.48, 0.44, 0.50 and 0.54% respectively

(fig.8). Maximum and minimum acidity were found to be in FJ-C and FMLJ-15% (0.66% and 0.44%). Acidity gives imperative effect on the gelation property of pectin (Mizrahi, 1979). The value of total acidity ranged from 1.00 to 0.5 which is in line with the standard value of good quality jam.

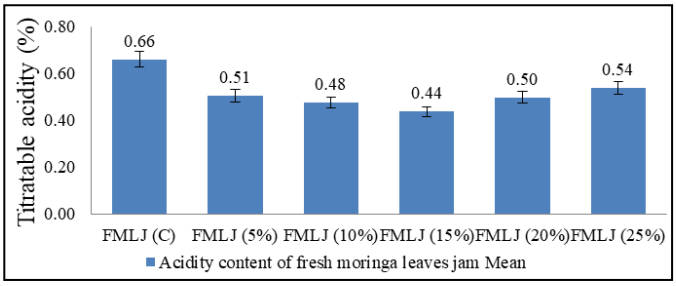

Fig 8: Titratable acidity content of fresh moringa leaves jam

3.2.8 Total Soluble Solids content

The total soluble solids of the products were the index of sweetness. TSS of different combination of fresh moringa leaf jam as determined by referectometer was found to be in the range of 68.54 to 70.70 ^{0}B (fig.9). Among the products studied, FMLJ-20% displayed highest TSS content (70.70^{0}B), closely followed by FMLJ-25% (70.59^{0}B), FMLJ-05% (69.81^{0}B), FMLJ-10% (68.78^{0}B), FJ-C (68.62^{0}B) and FMLJ-15% (68.54^{0}B) showed highest value of TSS content 70.70%. In most of the treatment combinations TSS content differed significantly.

The ^{0}Brix value of 68.0±0.71 recorded in the jam conforms to values recommended for jam to hinder microbial growth and maintain keeping quality (Aina JO and AA Adesina 1999, Moyls *et al.*, 1962 and Malcolum D., 2005) [1, 14, 12]. The ^{0}Brix value of the jam is also close to 65^{0}Brix recorded for syrup produced from black-plum fruit (Egbekun MK, 1996) [6].

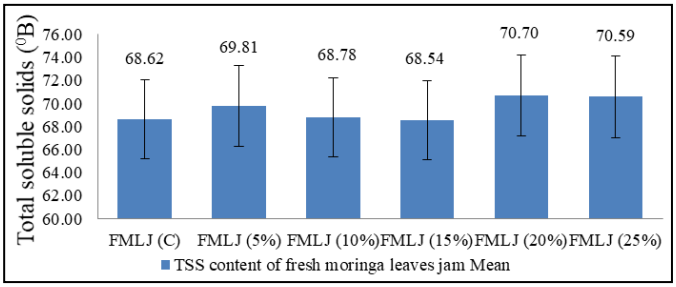

Fig 9: Total soluble solids content of fresh moringa leaves jam

3.2.9 pH value

The pH estimation was done in order to find out whether a low pH was maintained which could be an effective preservation. Maximum pH value was in FMLJ-20% (4.50) followed by FMLJ-25%, FMLJ-15%, FMLJ-05%, FJ-C and FMLJ-10%, (4.24, 3.92, 3.66, 3.63 and 3.33) respectively. pH value differed significantly in most of the different combination of fresh moringa leaves jam. pH 3.44 recorded in the jam conforms to values recommended for jam to hinder microbial growth and maintain keeping quality (Aina J.O. and A.A. Adesina 1999, Moyls *et al.*, 1962, Malcolum D. 2005) [1, 14, 12]. The pH of 3.33-4.50 of the current study (fig.10) is close to the reported pH 3.2 for optimum gel formation (Desrosier N.W., 1970) [5].

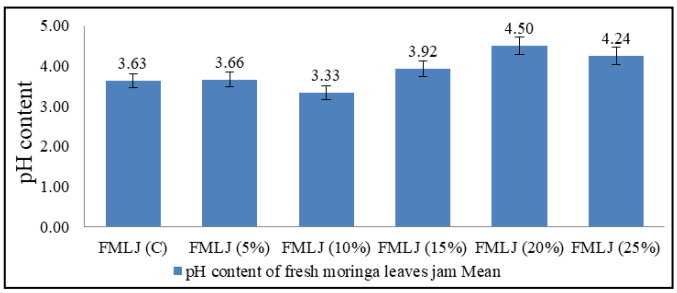

Fig 10: pH content of fresh moringa leaves jam

4. Conclusion

Results of the present study have shown that Moringa leaf is very rich in many important nutrients to human health such as fibre and proteins, significant minerals which means that this crop worth to be studied or investigated. Therefore, moringa leaves with its high fiber content and nutrient compositions can successfully be used for the preparation of jam to add value to the leaves. The combination (FMLJ-25%) incorporated with 25 percent fresh moringa leaves was considered best in physico-chemical qualities and showed good impact on nutritive value with regards to fiber, protein and ash content followed by the combination FMLJ-20%, FMLJ-15%, FMLJ-10%, FMLJ-05% and FJ-C. Therefore, the developed fresh moringa leaves jam (FMLJ) can be included in the daily diet of every age group which can definitely increase nutrient intake by maintaining the good health and promoting immunity against infections.

Through the same study, it has been proved that it could be practically to utilize moringa leaves in producing very important and palatable economic products such as moringa powder and moringa juice. It is also recommended to expand the area cultivated with moringa in future.

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