CHAPTER 2

DETERMINATION OF NUTRITIVE COMPOSITION OF MAHUDA FLOWERS

(EXPERIMENT I)

Objective 1. To determine nutritive composition of Mahuda flowers obtained from Chhotaudepur district of Gujarat.

Highlights of the results

The chemical composition of Mahuda flowers obtained from Chhotaudepur district of Gujarat, revealed that on an average the flowers contained 72.1% sugar of which 67.6% was reducing sugar.

Introduction

Two types of Mahuda flowers have been identified. Madhuca indica and Madhuca longifolia. Madhuca indica is found in mixed deciduous forests and is common in central and northern India. Madhuca longifolia is common in monsoon forest of western ghats and many parts of south India. However, both the varieties are compositionally so closely related to each other that hardly any distinction has been made between them(Wealth of India 1962).

Nutritional composition of Mahuda flowers

The chemical composition of Mahuda flowers as reported by Gopalan et al (1981), Shukla (1979), Rov and Rao (1959), Sutaria and Magar (1955a) and Abhyankar and Narayan (1942) is summarised in Table 2.1. The values for moisture and fibre contents were comparable with each other but those of crude protein, crude fat and ash content exhibited wide variations. The crude protein content of Mahuda flower ranged between 4 to 9.8% and the crude fat and ash content ranged between 0.2 to 1.5% and 2.7 to 4.5% respectively. The values for protein content reported by Shukla (1979) and Ro. and Rao (1959)were higher than those reported by Gopalan et al (1981), Sutaria and Magar (1955a) and Abhyankar and Narayan(1942). Likewise the fat content of Mahuda flowers reported by Shukla (1979) was 3 times that reported by Sutaria and Magar (1955a) and 7 times that reported by Abhyankar and Narayan(1942). The ash content of the flowers as reported by Sutaria and Magar (1955a) and Abhyankar and Narayan (1942) did not differ widely but that reported by Shukla (1979) and Ro. and Rao(1959) was nearly 60% higher than that observed by Sutaria and Magar (1955a). Such wide variations were

Table 2.1 Summary of the chemical composition of Mahuda flowers reported by various authors

	Gopalan et al (1981)	Shukla (1979)	Ko. & Rao (1959)	Sutaria & Magar (1955a)	Abhyankar & Nadkarni (1942)
Moisture (%)	13.6	22.0	NR	18.6	19.6
Crude protein (%)	4.4	5.9	6.8	4.4	3.0
Crude fat (%)	0.6	1.5	NR	0.5	0.7
Crude fibre (%)	1.7	1.6	NR	1.7	1.9
Ash (%)	NR	1.3	4.5	3.7	3.1
Total sugar (%)	72.0*	NR	66.7	72.9	61.3
Reducing sugar (%)	NR	NR	NR	52.8	46.5
Undetected matter	NR	NR	NR	NR	10.8

- NR = Not Reported
- *Total carbohydrate present in Mahuda flowers

ower, not observed in sugar content of the flowers although the values reported by Sutaria and Nagar (1955a) and Gopalan et al (1981) were the highest followed by those reported by Rao and Rao (1959) and Abhyankar and Narayan (1940). The variations found in chemical composition of Mahuda flowers might be due to the varietal differences as the flowers analysed were of Gujarat (Ghulia 1979), Madhya Pradesh (Roy and Rao 1984) and Maharashtra state (Sutaria and Nagar 1955a).

Sutaria and Nagar (1955a) have also demonstrated the presence of minerals like calcium, phosphorus and iron in Mahuda flowers. The authors analysed dried Mahuda flowers obtained from different districts of Maharashtra state for their mineral content and reported that calcium ranged between 180 to 240 mg%, phosphorus from 120 to 145 mg% and iron from 20 to 47 mg%. The authors concluded that regional variations were one of the important factors for observing such wide ranges in mineral content of Mahuda flowers.

The staple cereals in tribal diet are maize, wheat, rice and jodhi (Bhan 1958, 1959, Gopaldas et al 1981a). On an average these cereals contain 25 mg% calcium, 318 mg% phosphorus and 4.9 mg% iron (Gopalan et al 1981). Comparing the calcium, phosphorus and iron content of Mahuda flowers with those of the staple cereals of tribal diet, it seems that on percent basis, flowers contain nearly 8 times calcium and iron as compared to the staple cereals. Therefore Mahuda flowers could make a good source of calcium and iron in the place of staple cereals in tribal dietaries.

The chemical composition of Mahuda flowers reveals its superiority in total sugar content. However, wide variations have been observed in sugar content of Mahuda flowers collected from different places,

The data obtained in Table 2.2 indicate that the total sugar content of Mahuda flowers varies from 70.7% of Nasik flowers to 90% of Hyderabad flowers. Similar wide variations have also been reported in invert sugar content of flowers obtained from different states and from different regions of the same state. The total sugar content of Mahuda flowers collected from different places of Gujarat state however, seems to range between 65% to 70%. Whatever the degree of variations, one point comes out very clearly that Mahuda flowers are rich source of sugars.

Since wide variations had been observed in the total sugar content of Mahuda flowers collected from different places, it was thought important to conduct compositional analysis of Mahuda flowers obtained from Chhotaudepur district of Gujarat(objective one).

The flowers were analysed for

i) Moisture content
ii) Total protein content
iii) Total fat content
iv) Total sugar content
    a) Reducing sugar content
v) Total ash content
    a) Calcium content
    b) Phosphorus content

Table 2.2 Sugar content of Mahuda flowers collected from different places

Places	Cane sugar %	Invert sugar %	Total sugar %	Reducing sugar %	Reference
Hyderabad	17.1	40.0	57.1	NR	Elworthy (1897)
Jabalpur	4.6	41.4	46.0	NR	do
Gujarat	9.6	45.3	54.9	NR	do
Mirapur	6.7	NR	50.3	NR	do
Hyderabad	NR	NR	40.0	NR	Fowler et al (1920)
Gujarat	NR	NR	60.0	NR	do
Nasik	NR	18.01	70.31	52.30	Sutaria and Magar (1965a)
Nadiad	NR	14.90	70.10	55.20	do
Himatnagar	NR	17.07	67.12	49.85	do
Godhra	NR	14.57	69.52	54.95	do
E. Khandesh	NR	16.51	65.72	49.21	do
Prantij	NR	16.05	66.65	50.21	do

NR = Not Reported

Materials and Methods

Fort. Kilogram of fresh, light yellow coloured juicy blossoms of Mahuda flowers were received from the Gujarat State Forest Development Corporation, Chhotaudepur, Gujarat. The flowers were spread on filter papers and left under fan for twenty four hours to remove superficial moisture. About 12% of weight loss was recorded on air drying the flowers. The flowers were then subjected to sun drying for 3 to 4 days, they turned light brown on sun drying.

Preliminary work done in the department to explore the shelf life of fresh and processed Mahuda flowers indicated that fresh flowers could be stored only for 50 days in polythene bags while sundried flowers could be stored for over 6 months because of their reduced moisture content (unpublished data). Based on these findings in the present investigation, the sun dried Mahuda flowers were stored in polythene bags for a period of 6 to 8 months. These flowers have been used for determination of chemical composition and for conducting series of animal studies in the present investigation.

Analytical Procedure

1. Moisture

Moisture in any food stuff, is present in free and bound form. The latter is present as water of crystallization bound firmly to protein or to saccharide molecules and also adsorbed on the surface of colloidal particles. The loss of free water on heating is considered as the moisture content(Hart and Fisher 1971, Pearson 1976, Panganna 1977).

Moisture content was determined by the method of AACC(1962).

for 12 days. Mahuda flowers were kept in desiccator over super saturated sodium chloride solution to imbibe maximum moisture and to eliminate the effects of climate on moisture content (Winston and Bates 1960). Thereafter, in triplicate 2 g of the flowers were placed on pre-weighed aluminium foils and dried in an oven at 105°C to constant weight. The difference in the initial and final weight was taken as the moisture content. The percent moisture was calculated by the following formula:

$$\frac{\text{Moisture content of the sample taken}}{\text{Weight of the sample taken}} \times 100$$

2. **Total protein**

The method for protein determination was that of Oser(1970). In the Kjeldahl method, the various nitrogenous constituents present in a material are converted into ammonium sulphate by digestion with sulphuric acid. Ammonia which is liberated upon addition of alkali (sodium hydroxide) is collected in acid and measured by titration.

One gram of sample was digested with 20 ml of concentrated sulphuric acid and the digested solution was made up to 100 ml with distilled water. In duplicate, 1 ml aliquot was distilled with 40% of 10 ml sodium hydroxide solution. The ammonia liberated, was collected over 10 ml of 4% boric acid containing 2 drops of Bromocresol green and methyl red mixed indicator(Plummer 1971). The titration was done against 0.02 N sulphuric acid.

The protein of the sample was calculated as follows:

$$\frac{\text{titre value} \times 0.28 \text{ mg N}}{\text{g sample taken}} \times 100$$

Protein equalled N x 6.25

7. Total fat

The fat was extracted by the method of AACC(1962). Five gram of the moisture free sample was placed in a thimble in soxhlet apparatus containing ethyl ether. The extraction was continued for 16 hrs. The extract was quantitatively transferred to a small pre-weighed beaker and the solvent was evaporated. The percent fat was computed as follows:

$$\frac{\text{Fat content of the sample taken}}{\text{Weight of the moisture free sample taken}} \times 100$$

8. Total sugar

For determination of total sugar, the carbohydrate materials present in the samples are hydrolysed to reducing sugars by hydrochloric acid.

The total and reducing sugar content were estimated using modified method of Lane and Eynon (1965) as described in AOAC(1965). To 5 g of Mahuda flowers, 10 ml of 10 N HCL were added and the tubes were placed in boiling water bath for 2.5 hour to hydrolyze the carbohydrates. The contents were neutralized with 10 N NaOH to almost neutral PH (PH 6 to 7) and filtered. Then saturated solution of lead acetate (1 to 2 ml) was added to sediment the particles floating in the solution.

The contents were filtered to get clear hydrolysate. It was then made to 100 ml with distilled water.

Ten millilitre of the hydrolysate were mixed with five millilitre of Fehlings A and B solutions and was titrated against standard glucose solution using 2 to 3 drops of methelene blue as an indicator. The titration was continued over a flame until the appearance of cupric oxide as indicated by dark brick red colour.

Percent total sugar was calculated using the following equation

$$\frac{\text{titre value of the std} - \text{titre value of the unknown sample}}{\text{Fehling solution}} \times 0.5 \times \frac{\text{total vol. of sample after dilution}}{\text{ml of sample taken}} \times \frac{100}{\text{weight of sample taken}} = \% \text{ total sugar}$$

b. **Reducing sugar**

For determination of reducing sugar, 5 g of Mahuda flowers were soaked in 50 ml of warm distilled water and kept aside for overnight to facilitate complete solubility of the sugars present therein. The contents were filtered, the residue was washed 2 to 3 times with distilled water and discarded. To the filterate, saturated solution of lead acetate (1 to 2 ml) was added to sediment the particles present in the solution. The contents were filtered and diluted to 100 ml with distilled water. The titration followed was as described for total sugar determination. Percent reducing sugar was calculated using the equation described for calculating total sugar.

6. Total Ash

Mineral elements are present in foods as both organic and inorganic compounds. Ashing destroys all the organic matter leaving inorganic matter behind(Hart and Fisher 1971).

The method of AACC(1960) was employed to determine ash content. Into a pre-weighed German crucible, in triplicate , 2 g of the sample were weighed and ashed in electric muffle furnace at 550 °C for 16 hours until the ash colour was light grey. The crucibles were cooled in a desiccator and re-weighed. The process was repeated until constant weight was obtained. The percentage ash in the sample was calculated from :

$$\frac{\text{ash content of the sample taken}}{\text{weight of the sample taken}} \times 100$$

7. Calcium content

Calcium was determined by precipitating it as calcium oxalate and titrating the solution of calcium oxalate in dilute sulphuric acid against standard potassium permanganate(AOAC 1970).

The ash was dissolved in a drop of concentrated nitric acid and the volume was made with distilled water so as to get 1 mg ash/ml solution. In triplicate, 1 ml sample of the diluted ash was taken in centrifuge tubes and 1 ml of glass distilled water was added. Two to three drops of bromocresol green indicator

followed by saturated solution of sodium acetate were added to change PH to 4.8 to 5 as indicated by formation of blue colour. The tubes were covered with watch glass and heated to boiling point. The calcium was precipitated by adding slowly 5% oxalic acid solution, one drop every 3 to 5 seconds, until PH was 4.4 to 4.5 (optimum for calcium oxalate precipitation) as indicated by distinct green colour. The tubes were placed in boiling water bath for 1 or 2 minutes and were left aside overnight. The contents were centrifuged and supernatant was carefully drained off. The precipitate was washed with 10.0 ml of ammonia solution repeatedly till the solution became colourless. The precipitate was then dissolved in 10.0 ml of 1 NH_2SO_4. The tubes were kept in an oven at 80° C for 5 minutes and the contents titrated against standard $1M_nO_4$ solution(1 ml of 0.1N (1 M_nO_4 = 0.2 mg of calcium).

Calcium content was calculated using the following equation :

$$\frac{\text{Titre val.} \times 0.2 \text{ mg Ca}}{\text{Volume taken for estimation}} \times \frac{\text{total vol. of ash sol.}}{\text{wt. of sample taken for ashing}} \times 100 = \text{mg\% Ca}$$

8. Phosphorus Content

The phosphorus content of the sample was determined using the method of Fiske and Subbarow (1925). The estimation was carried out by measuring the blue colour formed when the ash solution was treated with ammonium molybdate. This blue colour was used as a measure of the amount of phosphate present in the sample.

In triplicate, 0.1 ml aliquot of diluted ash was taken in test tubes to which 1 ml of ammonium molybdate followed by 3 ml of

hydrosulphite and 1 ml Nessler solution were added. The contents were mixed well after each addition. The volume was made up to 15 ml with glass distilled water and contents were mixed thoroughly. After 20 minutes, the optical density was measured in a photoelectric colorimeter against a reagent blank (prepared in the same way as the test except the test solution was omitted) using a red filter (650 nm). The phosphorus content of the sample was read off from a standard curve prepared with standard phosphate solution (range 0.01 - 0.1 mg phosphorus).

Results and discussion

Table 2.1 presents the chemical composition of Mahuda flowers of Chhotaudepur. The moisture content of sun dried Mahuda flowers averaged to 17.2%. This value is quite comparable with that reported by Abhyankar and Narayan (1943), Sutaria and Magar(1955a) and Gopalan et al (1983). However, the moisture content of Mahuda flowers analysed by Shukla(1977) was slightly higher than that observed in the present study(22.8 Vs 17.2%). The variation in the results might be due to the degree of dryness of the flowers. Shukla (1977) did not mention about the procedure used by him to dry the flowers before the flowers were analysed for their moisture content. The flowers used by Sutaria and Magar (1955a) and Abhyankar and Narayan (1943) for moisture determination, were air and sun dried respectively. In the present experiment as stated earlier, sun dried flowers were used.

The protein content of Mahuda flowers ranged between 3.7 to 4.6% with a mean of 4.1% (Table 2.1). Similar values have been reported by Sutaria and Magar(1955a) and Gopalan et al (1983). But the

Table 2.3 Chemical composition of Mahuda flowers

Parameters	Mean	Range
	Amount per 100 g	
Moisture(g)	19.2	18.8 - 19.8
Total protein(g)	4.1	3.7 - 4.6
Total fat(g)	2.2	2.1 - 2.4
Total sugar(g)	72.1	70.0 - 72.8
Reducing sugar(g)	57.4	55.7 - 58.1
Total ash(g)	2.1	2.1 - 2.5
Calcium(mg)	135.0	131 - 138
Phosphorus(mg)	110.0	114 - 107

protein content higher by 25% (Ro. and Rao 1959) and 44% (Shukla 1979). And lower by 3% (Abhyankar and Narayan 1942) has also been reported. The mean value for fat content of sun dried Mahuda flowers was 2.3% with the range being 1.1 to 3.4%. The fat content of Mahuda flowers as low as 0.2% has been reported by Abhyankar and Narayan (1942). The variations in protein and fat content were attributed to varietal differences of the flowers.

The total sugar content of Chhotaudepur Mahuda flowers was 72.1% (Table 4.3). Earlier Sutaria and Magar (1955a) have reported similar value (72.9%) for total sugar content of air dried Mahuda flowers. However, Abhyankar and Narayan(1942) and later Ro, and Rao(1959) have reported somewhat lower values(61 and 67% respectively). The differences observed in the total sugar content were attributed to regional variations. Because such wide variations had been observed in sugar content of Mahuda flowers obtained from various states and various places of Gujarat State(Table 4.2).

In the present experiment I, the reducing sugar estimated to 80% of the total sugar content (57.6 of 72.1%). Sutaria and Magar (1955a) and Abhyankar and Narayan(1942) had earlier reported that nearly 75% of the total sugars were in the form of reducing sugar. Much earlier, Fowler et al (1920) had demonstrated the presence of glucose, fructose, maltose, sucrose and pentose among Mahuda sugars and reported that glucose and fructose formed nearly 70% of the total sugars.

The total ash content of Mahuda flowers was found to be 2.7% which compared well with that reported by Sutaria and Magar(1955a). The ash content of flowers was however lower than that reported by Abhyankar and Narayan (1942), Ro, and Rao(1959) and Shukla (1979).

The calcium and phosphorus content in dried Mahuda flowers were 165 and 120 mg% respectively. The comparison of these values with calcium and phosphorus content of Mahuda flowers reported by other investigators is presented below :

Calcium and phosphorus content of Mahuda flowers

	Sutaria and Magar (1955a)	Shukla (1979)	Gopalan et al (1981)	Present experiment
Calcium(mg%)	140	170	140	165 (125 - 175)
Phosphorus(mg%)	140	120	140	120 (114 - 127)

() Range

The values for calcium and phosphorus content observed in the present investigation are in confirmation with those reported by Sutaria and Magar(1955A), Shukla(1979) and Gopalan et al (1981).

Based on the chemical composition of Mahuda flowers obtained from Chhotaudepur district of Gujarat(Experiment 1), it was hypothesised that these flowers could be used as a major food energy source in the supplementary feeding programmes particularly for tribal population, if found suitable for human consumption.