CHAPTER 6

SUMMARY AND CONCLUSIONS

In Gujarat, especially in Chhotaudepur and Panchmahal districts, Mahuda trees are widely distributed in and outside forest areas (Abhyankar and Narayan 1942, Joshi 1979). Mahuda tree is important to the hill tribes as it yields edible flowers and oil seeds in addition to timber and fire wood. The tribals utilize all the parts of Mahuda tree such as seeds, fruits, flowers and bark (Wealth of India 1962). Due to a strong belief among the tribals of Chhotaudepur, that the consumption of Mahuda flowers causes diarrhoea, flatulance and other digestive problems, the flowers form a major food source only during the lean season and famine (Gopaldas et al 1983b). Also, the pregnant and lactating women do not eat Mahuda flowers because of the belief that it is a hot food and causes abortion. The chemical composition of air dried Mahuda flowers has revealed that on moisture free basis, the flowers contain nearly 75 to 83% of sugar and have appreciable amounts of vitamins and minerals (Wealth of India 1962). The seeds of Mahuda tree yield about 40 to 50% edible oil (Joshi 1979). Mahuda seed cake is considered unsuitable for incorporation in animal feed because it contains 7% saponin (Mulky and Gandhi 1977). In rats, the toxic effect of Mahuda seed saponin leading to death, has also been reported (Menon 1977).

Since, Mahuda flowers are rich source of carbohydrate (in the form of sugars) and vitamins it was envisaged that the flowers could serve as an important supplementary food for the tribals if found safe for human consumption. But it has been reported that Mahuda seed meal contain toxic substance like saponin, it might be that Mahuda flowers being part of the same tree, also contain some toxic

substances. Thus it was considered necessary to establish the safety of Mahuda flowers to be consumed as an energy source. The present investigation was therefore, designed to explore the possible use of Mahuda flowers as an energy yielding dietary component. The safety and feasibility of Mahuda flowers as a dietary component, was investigated in animal model, using vulnerable groups of rats.

The specific objectives of the study were to

(a) determine nutritive composition of Mahuda flowers, (b) explore the effect on growth and bio chemical status of weanling rats, of feeding pressure cooked for 10 to 20 minutes, Mahuda flowers as the source of carbohydrate, (c) explore the level of Mahuda flowers in the diet, that would support growth in weanling rats when used as a carbohydrate source, (d) explore the effect of feeding pressure cooked Mahuda flowers as the source of carbohydrate on the nutritional status of pregnant rats and on the products of reproduction, (e) investigate the effect of feeding pressure cooked Mahuda flowers as the carbohydrate source, on the lactational performance of the dams in terms of growth rate of pups upto weaning age, (f) isolate and identify saponin if present, in Mahuda flowers, (g) conduct pharmacological investigations to explore the effects of alcoholic and water extracts of Mahuda flowers on isolated duodenum of rabbit and fundus of rat, (h) explore the possibility of removing saponin from Mahuda flowers by steam treatment and to evaluate the nutritive quality of steam treated flowers in terms of growth of weanling rats. In all, 5 experiments were conducted to fulfil the above mentioned objectives. In experiment IV and V, 2 and 3 separate studies respectively were carried out.

Experiment I

Two types of Mahuda flowers have been identified, Madhuca indica and Madhuca longifolia. The former variety is found in mixed deciduous forests and is common in central and northen India, while the latter variety is found commonly in monsoon forest of western ghats and many parts of south India (Wealth of India 1962). Both the varieties have been found compositionally related to each other. The total sugar content of Mahuda flowers reported by various authors ranged between 61.1 to 72.9%. The variations found in total sugar content might have been due to varietal differences as the flowers analysed were from 3 different states, Gujarat (Shukla 1979), Madhya Pradesh (Rao and Rao 1959) and Maharashtra (Gularia and Nagar 1955a). 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.

Forty kilogram of fresh, light yellow coloured juicy blossoms of Mahuda flowers were received from Gujarat State Forest Development Corporation, Chhotaudepur, Gujarat. The flowers turned light brown in colour on sun drying for 3 to 4 days. The sun dried flowers were used for determination of chemical composition and for conducting series of animal studies in the present investigation. The Mahuda flowers were analysed for moisture, total protein, total fat, total sugar and reducing sugar, total ash, Calcium and phosphorus contents

(see below)

The nutrient composition of Mahuda flowers

Nutrient		Amount per 100g
Moisture	(g)	19.7
Total protein	(g)	4.1
Total fat	(g)	2.2
Total sugar	(g)	72.1
Reducing sugar	(g)	57.6
Total ash	(g)	2.3
Calcium	(mg)	175.0
Phosphorus	(mg)	120.0

The nutrient composition of Mahuda flowers observed in the present experiment compared well with that reported by various authors. The flowers contain 72% of sugar. It was envisaged that the flowers being rich in carbohydrates could be used as a major food energy source in the supplementary feeding programmes particularly for tribal population, if found suitable for human consumption.

Experiment II and III

Mahuda flowers are utilized by tribals of Chhotaudepur district, Gujarat, whenever there is a scarcity of foods (Gopaldas et al 1983b). Often, the flowers are roasted or crushed and incorporated into dal or into chappati dough or mixed with other cereals to prepare Bhakri and Vada (Mane 1984). The effect of feeding chicks for 28 days, isonitrogeneous diet containing Mahuda flowers at 0,4,8,12, and 16% levels was examined by Vyas (1967). The findings indicated that normal weight gain and maximum feed utilization were

observed in chicks fed diet containing 8% Mahuda flowers but at 12 and 16% level, the growth rate tended to decrease. Preliminary studies were conducted in this department to investigate the feasibility of Mahuda flower sugar (concentrated water extract of Mahuda flowers called syrup), to replace carbohydrate in rat diet (Rajgor et al 1986). The results indicated that weanling rats fed ad libitum for 28 days, diet containing Mahuda syrup exhibited decreased food intake and consequently, lower weight gain. The decrease in food intake was attributed to stickiness of the diet caused by Mahuda syrup. Thus to avoid stickiness of the diet, in the present experiments instead of Mahuda syrup, Mahuda flowers were incorporated into rat diet, as the carbohydrate source.

Since Mahuda seeds contain saponin and since heat treatment to foods is known to destroy anti-nutritional factors such as trypsin inhibitor, saponin, haemagglutinins, cyanogenetic glycosides and goitrogens, polyphenolic compounds and phytic acid which are present in various plant products, it was considered essential to subject Mahuda flowers to heat treatment prior to their incorporation into rat diet. The present experiments were therefore, planned with the main objective of using pressure cooked Mahuda flowers as an energy yielding component in the diet of weanling rats. The experiment II was planned to explore the effect of feeding pressure cooked for 10 or 20 minutes, Mahuda flowers as the source of carbohydrate, on growth and bio-chemical status of weanling rats. While experiment III was conducted to investigate the safe level of Mahuda flowers in the diet that would support growth in weanling rats, when used as a carbohydrate source.

The effects of feeding ad libitum for 28 days diet containing

pressure cooked Mahuda flowers as the source of carbohydrate were evaluated against those of feeding diet containing sago as the carbohydrate source. The sago-bengalgram diet (control diet) provided 11.2g protein and 68g of carbohydrate. Of the total carbohydrates in this diet, 32g was provided by bengal gram and 36g by sago. In Mahuda diet (experimental diet), to obtain 36g of carbohydrate, 50g of Mahuda flower powder was incorporated per 100g diet. The effect of feeding diet containing 10 minutes pressure cooked Mahuda flower powder fed at 50% level (50M10 diet/group) was observed on growth rate, food intake and organ weights in weanling rats. The controls received sago-bengalgram diet (SB diet/group). In experiment III, the rats were fed for 28 days, diet containing either sago to provide 36g of carbohydrate (SB diet) or 50 or 25g Mahuda flower powder to provide 36 or 18g of carbohydrate. The powder was prepared from Mahuda flowers which were pressure cooked for either 10 (25M10 diet/group) or 20 minutes (25M20 and 50M20 diet/group). The effects of feeding Mahuda diets were evaluated against those of feeding SB diet or Casein diet (C diet) in terms of growth, food intake, organ weights, moisture content of various organs and bio-chemical status in weanling rats.

The findings of the experiment II (Table 6.1) suggest that the 50M10 diet was nutritionally inferior to the SB diet as the weight gain of weanling rats fed 50M10 diet was significantly lower than those fed SB diet. Except livers, the 50M10 diet exerted injurious effects on vital organs (heart, kidneys, intestine). These adverse effects on growth, food intake and organ weights were attributed to the presence of some growth depressor which was either not heat labile or that the Mahuda flowers were not cooked for long enough time to destroy the so called anti-nutritional factor/s.

Table 6.1 Summary of the results of experiment II and III

Effect of feeding Mahuda flowers, cooked for 10 or 20 minutes, at 25 or 50% level, on growth and bio-chemical status of weanling rats in comparision to those fed sago-bengalgram diet.

Groups fed Mahuda flower	Mahuda flower groups Versus sago-bengalgram group
25M10 and 50M20	20 to 29% decrease in food intake and 41 to 51% decrease in bod. weight gain
25M10, 50M10 and 50M20	enlargement of organs like heart, brain, kidneys and intestines
25M10, 25M20 and 50M20	no significant effect on the moisture content of the organs
25M10 and 50M20	12 to 14% increase in hepatic lipid content
25M10 and 50M20	22 to 25% decrease in hepatic glycogen and 11 to 18% decrease in blood sugar level
25M10, 25M20 and 50M20	no adverse effect on the haematological status.
25M10, 25M20 and 50M20	moderate alteration in serum albumins but no significant effects on total serum proteins

The results of experiment III revealed that regardless of cooking time, the Mahuda flowers incorporated at 25 or 50% level into the diet, adversely effected food intake, growth rate, organ weights and biochemical status of the weanling rats (Table 6.1). However, the degree of adverse effect was related to the levels of Mahuda flowers in the diet. The growth rate of the rats fed diet containing 25% Mahuda flower, was higher than that of those fed 50% Mahuda flower diet. Also, the effects on growth and biochemical status were less deleterious when the cooking time was increased from 10 to 20 minutes, perhaps due to partially or fully, inactivation or destruction of anti-nutritional factor present in Mahuda flowers.

The values for food intake, body weight, and organ weight of rats fed 25M20 diet were higher than those fed 25M10 or 50M20 or 50M10 diets and were more closer to the control values. It appeared from these results that it would not be unsafe to consume if necessary, 25g of Mahuda flowers cooked for 20 minutes per 100g diet. Therefore for all other experiments the diet used contained 25g Mahuda flowers cooked for 20 minutes per 100g diet (25M20 diet).

Experiment IV

Among the tribals, mild apprehension existed towards free utilization of Mahuda flowers as a food source for all age groups (Gopaldas et al 1983c). The pregnant women were not consuming Mahuda flowers because of the belief that it is a hot food and has abortifecient nature. The lactating mothers refrained from eating Mahuda flowers for the fear that the consumption of flowers might cause gastro-intestinal upsets in the infant (Gopaldas et al 1983a,b). Adverse effects of consumption of foods containing some toxicants, on pregnancy performance have earlier been reported.

Lower maternal weight gain and increased level of thiocyanate in amniotic fluid of the pregnant rats fed cassava diet have been observed (Tewe et al 1977). The saponin from the perennial herbaceous plant which is known as the Broom weed, had adversely effected the size, maturity and strength of the foetuses of cows (Dollahite and Anthony 1957). Placenta is the most vital organ for fetal development. Certain drugs or food toxicants have caused histopathological changes in the rat placenta, reduction in weight and volume of placenta, length of umbilical cord and volume of amniotic fluid followed by fetal growth retardation (Padmanabhan and Singh 1978, 1980).

Since Mahuda flowers are rich source of carbohydrates but its use is restricted during pregnancy and lactation. The experiment IV was designed to explore the impact of feeding Mahuda flowers as the source of carbohydrate, on the nutritional status of pregnant rats, lactating dams and their offsprings. This experiment comprised of two studies.

Study 1 was designed to determine effects on the nutritional status of pregnant rats and on the products of reproduction, of feeding 25M20 diet during first half or second half or entire period of gestation. While the study 2 was planned to investigate the effects on the lactational performance of the dams in terms of growth of pups upto 21 days and nutritional status of pups, of feeding the dams on 25M20 diet during entire gestation plus lactation period or during only gestation period or during only lactation period.

The effects of feeding 25M20 diet were evaluated against those of feeding SP or C diet. For study 1, parameters used were, maternal weight gain, food intake, litter size, average fetal weight and

placental weights, serum protein levels and A/G ratio, haemoglobin level and histopathology of placenta. The five groups of pregnant rats fed various diets for 20 days of gestation period were (a) casein diet fed throughout the gestation period (C diet/group), (b) sago-bengalgram diet fed throughout the gestation period (SB diet/group), (c) 25%M diet fed throughout the gestation period (M diet/group), (d) SB diet fed during first half and M diet during the second half of gestation period (SBM diet/group), (e) 25%M diet fed during the first half and SB diet during the second half of gestation period (MSB diet/group).

In study 2, evaluation was based on maternal body weight changes, food intake, litter size, litter weight, pup weight on weanling day (21 days), organ weights of weaned pups, hepatic lipid content of weaned pup and serum proteins of weaned pups. The five groups fed various diets during the gestation (P) plus lactation (L) periods were (a) C diet fed throughout the gestation and the lactation periods (P-L, diet/group), (b) SB diet fed throughout the gestation and the lactation periods (P-LSB diet/group), (c) 25%M diet fed throughout the gestation and the lactation (P-LM diet/group) periods, (d) SB diet fed during the gestation and M diet during the lactation (PSB-LM diet/group) periods, (e) M diet fed during the gestation and SB diet during the lactation (PM-LSB diet/group) periods.

The results of the study 1 (Table 5.2a) indicated that inclusion of Mahua flowers into the diet of pregnant rats did not alter acceptability of the diet as the food intake did not vary between M and SB diet fed groups. But rats fed M diet either throughout the gestation (M group) or during the first half of the pregnancy period

Table 6.2a Summary of the results of experiment IV (Study 1)

Effect of feeding Mahuda flower diet on the nutritional status of pregnant rats and their products of reproduction in comparision to those fed sago-bengalgram diet.

Groups fed Mahuda flower	Mahuda flower groups Versus sago-bengalgram group
M, SBM and MSB	no appreciable variations in food intake
M and MSF	19 to 21% decrease in body weight gain
M and MSB	11 to 18% decrease in litter size
M, SBM and MSF	no adverse effects on litter and placental weights
M and MSB	moderate decreases in serum albumins consequently decreases in A/G ratio
M, SBM and MSB	no adverse effects on the haemato-logical status
M and MSB	histopathologically, marked abnormal changes in placenta

(MSB group) gained 19 to 21% less weight than those fed SB diet. Also 11 to 18% decrease in litter size was observed in former groups as compared to the latter group. But the average litter weight and weight/placenta of rats fed M or SB diets did not vary from each other. Also, the serum total protein levels and the haematological status were not altered in response to feeding of Mahuda diets. Histopathologically, abnormal changes in placenta of the rats fed Mahuda diet were noted. These placental changes were more marked in rats fed Mahuda diet either during the entire period of gestation or during the first half of the gestation period than of those fed Mahuda diet during the second half of the gestation period.

The findings of study 2 (Table 6.3b) indicated that dams fed ESMM diet during the pregnancy and/or until 21 days of the lactation period exhibited no variation in food intake (P-LM, PM-LSB, PSB-LM groups). But the dams of P-LM or PM-LSB groups gained 19 to 28% less weight than those of PSB-LM or P-LSB groups. Also the litter size was smaller by 2 litters when dams were fed Mahuda during the entire gestation period (P-LM and PM-LSB groups). However, the birth weight of pups was not adversely affected by feeding Mahuda diet to dams during the gestation period (P-LM and PM-LSB Vs P-LSB groups). But, the pups weaned at 21 of days age, nursed by the dams fed on Mahuda diet at any stage, during the gestation or lactation periods (P-LM or PM-LSB or PSB-LM groups) exhibited growth arrest. In addition, hypertroph. of kidneys, heart and intestines was observed in pups of dams fed Mahuda diet. No striking alterations were recorded in hepatic lipid contents, in haemoglobin levels and in serum protein levels of the pups nursed by dams fed on Mahuda diet (P-LM or PM-LSB or PSB-LM groups).

Table 5.2b Summary of the results of experiment IV (Study 2)

Effect of feeding Mahuda diet on the lactational performance of dams and their off-springs in comparision to those fed sago-bengalgram diet.

Groups fed Mahuda flower	Mahuda flower groups Versus sago-bengalgram group
P-LM, PM-LSB and PSB-LM	no variations in food intake
P-LM and PM-LSB	25 to 28% decrease in body weight gain of the females
P-LM and PM-LSB	15 to 20% decrease in litter size
P-LM, PM-LSB and PSB-LM	no effects on birth weight of the pups
P-LM, PM-LSB and PSB-LM	stunted growth of the pups
P-LM and PM-LSB	hypertrophy of kidneys, heart and intestines
P-LM, PM-LSB and PSB-LM	no alterations in hepatic lipid content of the pups
P-LM, PM-LSB and PSB-LM	no adverse effect on the haematological status of the pups
P-LM, PM-LSB and PSB-LM	no striking alteration in serum total proteins of the pups
P-LM and PM-LSB	moderate increase in beta and gamma fractions of globulins in the pups

Both the studies of experiment IV indicated that during the period of gestation and lactation, it would not be safe to consume Mahuda flowers to contribute about 70% (25g of Mahuda flowers/100g diet) of the total carbohydrate in the diet. But, if flowers are to be eaten due to agriculturally lean months or famines, it is suggested that the dietary preparation containing Mahuda flowers should be avoided during first half period of gestation. These results support the superstition of the tribal women that consumption of Mahuda flowers cause ill effects on reproductive performance.

Experiment V

The Mahuda seed, locally known as Doli yields about 40 to 50% edible oil. It has been reported that Mahuda seed cake contains 7% saponin, which is highly toxic than the tannins in sal meal (Mulky and Gandhi 1977). Saponins are glycosides of both triterpenes and sterols and have been detected in over seventy families of plants (Rasik and Kachroo 1967). A single dose of concentrated saponin extract of Mahuda meal administered through stomach tube to rats produced intense inflammation of the intestine with sloughing of the superficial epithelial cells within a few hours after dosing (Pradhan et al 1976). It has been reported that Mahuda saponin was extremely toxic when administered intraperitoneally (Mulky and Gandhi 1977). When saponin was orally ingested, it was not absorbed directly, but caused destruction and sloughing of the superficial layers of the intestinal mucosal membrane followed by intense inflammation thereby resulting in some degree of absorption of saponin through hypodermic tissues. The invitro pharmacological studies to explore the effects of saponin of Mahuda seeds, on isolated rabbit duodenum and rat stomach fundus have indicated that

addition of saponin in isotonic urian bath caused stimulant (irritant) effect followed by death of the tissue (Mulay and Gandhi 1977).

Since, Mahuda seed cake contains 7% of saponin, it was thought that the Mahuda flowers being part of same tree, might also be containing some amount of saponin which probably was responsible for decreased growth rate observed in the weanling rats, lower maternal weight gain in the pregnant rats and depressed growth in pups of the lactating rats. Also, the contractile effects of Mahuda seed saponin on rabbit duodenum and rat fundus had been reported. Thus experiment V comprising of three separate studies was planned to isolate and identify saponin if present in Mahuda flowers (study 1), to find out in-vitro effects of alcoholic and water extracts of Mahuda flowers on isolated duodenum of rabbit and fundus of rat (study 2) and to investigate the possibility of removing saponin from Mahuda flowers by steam treatment was explored and the nutritive quality of steam treated flowers was investigated in terms of growth of weanling rats (study 3).

In study 1 saponin was isolated and identified using column and thin layer chromatograph, techniques. In study 2, the effect of different concentration of alcoholic and water extracts of Mahuda flowers were recorded on the slow moving drum using the isotonic frontal lever and were compared against those of acetylcholine. For study 3, weanling rats were fed for 28 days, diet containing 25g of Mahuda flower powder, made from Mahuda flowers which were steamed for 30 minutes and dried in oven at 80° C for 3 to 4 days (25%/ diet/group). The data obtained on growth rate, food intake and weight of the organs, was compared with the corresponding values of

weanling rats fed SF or 25M20 diet (Chapter 5)

The presence of saponin in the Mahuda flowers (study 1) was confirmed when the first elute portion collected through column chromatogram gave positive reaction with Liebermann-Burchard reagent (appearance of pink colour). The exact position of saponin band was found in region from about Rf 0.56 to 0.61. The Mahuda flowers were found to contain 2.56% of crude isolate saponin which had acrid smell and foam forming activity. Varied concentration of saponin (study 2) in the alcoholic (1, 2, and 3 mg saponin) and water (3, 6, and 12 mg saponin) extracts of Mahuda flowers generated irritation on the smooth muscles of the gastro-intestinal tract and produced a moderate non-reactivity of rabbit duodenum and stomach fundus of rat. The findings of study 3 indicated that weanling rats fed 25M20 diet (steam treated Mahuda flowers) exhibited a loss of appetite and consequently retardation of growth. Comparing the food intake of rats fed steam treated flowers with those fed pressure cooked Mahuda flowrs (25M20 diet fed rats), it was observed that the former group ate nearly 1/3rd of the amount of food eaten by the latter group hence the growth rate of rats fed steam treated flowers was less than 50% that of the rats fed 25M20 diet. Also, the liver and kidneys of the 25M20 diet fed rats were found to be enlarged. It appeared that the process of steaming followed by oven drying could not detoxify Mahuda flower saponin or any other toxicant present therein, so as to make them a potential alternative food energy source.

The results of three studies of the experiment V (table 6.3) lead to the conclusion that Mahuda flowers contain 2.56% of crude isolate saponin which exerted contractile effect on the smooth muscles of

Table 6.3 Summary of the results of experiment V (Study 1, 2 and 3)

Study 1

Mahuda flowers contain 2.56% crude isolate saponin.

The Rf value of Mahuda flower saponin lied between 0.56 and 0.63. Mahuda flowers saponin had acrid smell and foam forming activity.

Study 2

The alcoholic and water extracts of Mahuda flowers containing varied concentration of saponin generated irritation on the smooth muscles of the rabbit duodenum and rat fundus.

Study 3

Effects of feeding 20 minutes steamed Mahuda flowers (25%30 diet) on the growth and organs of weanling rats in comparison to those fed pressure cooked Mahuda flowers (25%30 diet).

25%30 Vs 25%'0 groups

Loss of appetite

Growth retardation

Enlargement of liver and kidneys

gastro-intestinal tract. Also, the saponin and/or any other toxicant present in Mahuda flowers could not be detoxified by simple steam treatment. It may also be that during the process of steam treatment, carbohydrate from Mahuda flower might have got complexed with some component of Mahuda flower or with the toxicant present in the flower, whereby the carbohydrate became unavailable. This hypothesis is based on the fact that the growth rate of pressure cooked Mahuda flowers fed rats was better than that of those fed steam treated oven dried flowers.

Table 2.4 summarizes the results of the 5 experiments carried out in the present investigation. The Mahuda flowers used in the series of experiments contain 72% sugars of which 57.5% was reducing sugars. The intake of Mahuda flowers to provide 1/4 of the total carbohydrate exerted adverse effects on the growth of weanling rats, on the maternal weight gain in pregnant rats and impaired growth of pups of the lactating dams. These effects were attributed to 2.56% crude isolate saponin present in flowers, or any other anti-nutritional factor/s present therein. Also, varied concentration of saponin from alcoholic and water extracts of Mahuda flowers produced irritation on the smooth muscles of the gastro-intestinal tract. In addition, the process of steaming and oven drying did not detoxify its saponin content or any other anti-nutritional factor/s.

In view of the above results of the series of experiments conducted on vulnerable groups of rats, the author feels inclined to state that despite its rich carbohydrate content (72%) in the form of sugars and vast availability, Mahuda flowers may not be recommended for human consumption in the supplementary feeding programme as a

Table 6.4 Highlights of the present investigation

Experiments				
I	II	III	IV	V
1. Mahuda flowers contain 72% of carbohydrate in the form of sugars. 2. Of the total sugar content, 57.6% was reducing sugars.	1. 50Mlo diet was nutritionally inferior to the 50 diet. 2. Food intake in rats fed sago-bengal gram or Mahuda diet did not differ from each other.	1. Regardless of cooking time, the degree of adverse effect on growth rate of rats was related to the levels of Mahuda flowers in the diet (25 or 50 g per 100 g diet). 2. It would not be unsafe to consume Mahuda flowers cooked for 20 minutes, at the level of 25 g per 100 g diet, during the period of growth if necessary.	1. The consumption of Mahuda flowers in early part of pregnancy was harmful. 2. the pups weaned at 21 days of age, nursed by the dams fed on Mahuda diet at any stage during the gestation or lactation periods, exhibited growth arrest. 3. Intake of Mahuda flowers caused ill effects on reproductive performance.	1. Mahuda flowers contain 2.56% of crude isolate saponin with Rf value ranging between 0.56 to 0.5.. 2. Pharmacologically, varied concentration of saponin from alcoholic and water extracts of Mahuda flowers generated irritation on the smooth muscles of the gastro intestinal tract. 3. The process of steaming did not detoxify Mahuda flowers saponin content or any other anti-nutritional factors.

major food energy source on account of the presence of anti-nutritional factor like saponin, which is likely to produce adverse/toxic effect on the nutritional status of the consumer. Nevertheless, the study has shown that during agricultural lean months or famines, Mahuda flowers may be consumed as a dietary component in an amount not exceeding 1/4th of total carbohydrate content of the diet and should be pressure cooked for not less than 20 minutes. However, the utility of Mahuda flowers largely remains subject to the condition within the frame work of certain constraints like the age group (infancy, pregnancy and nursing women), and until any simple and economically cheap technology is discovered, to detoxify Mahuda flowers at home level.

Suggestions for further research work

1. Determination of availability of sugars of cooled Mahuda flowers.
2. Investigation for the presence of any tuxicant/anti-nutritional factor other than saponin, in Mahuda flowers.
3. Formulation of method/s to detoxify Mahuda flower saponin prior to its utilization as a food energy source.
4. Further pharmacological studies.