EUROPEAN JOURNAL OF BIOMEDICAL AND PHARMACEUTICAL SCIENCES
http://www.ejbps.com

ISSN 2349-8870
Volume: 3
Issue: 9
321-329
Year: 2016

UTILIZATION AND NUTRITIONAL EVALUATION OF BABUL BARK (*Acacia Arabica)* FOR THE DEVELOPMENT OF VALUE ADDED PRODUCT TO IMPLEMENT ON THE DIABETIC PATIENT

Jaya Sinha*[1] and Zeba Naz[2]

University Department of Clinical Nutrition and Dietetics., Vinoba Bhave University., Hazaribag., Jharkhand.

***Author for Correspondence: Jaya Sinha**
University Department of Clinical Nutrition and Dietetics., Vinoba Bhave University., Hazaribag., Jharkhand.

Article Received on 21/06/2016 **Article Revised on 12/07/2016** **Article Accepted on 04/08/2016**

ABSTRACT
Babul bark is worldwide distributed. In India it is widely observed from Rajasthan, Gujarat, Uttar Pradesh, Bihar, Jharkhand**,** Bengal and Orissa. Babul tree is of significant importance in Ayurveda, Unani medicine and African folk medicine. Babul tree contains Arabinose, Galactose, Rhamnose and Glucuronic acid. Barks are rich source of micronutrients such as Vitamin-C, Iron, Calcium, Carbohydrate (found in babul in less amount in polysaccharide form). It is a richest source of Tannins which are responsible for reducing Blood sugar level. The study was undertaken with the objectives (i) to process Babul bark in powder form and find out the component changes after dehydration (ii) To introduce the babul plant as medicinal uses for reducing the complication of diabetes by preparing biscuits enriched with babul bark powder (iii) to assess the organoleptic quality of biscuits enriched with babul bark powder (iv) To evaluate the effectiveness of babul bark biscuits on diabetic patient after intervention. The present study was an attempt to utilize the medicinal bark to develop value added product namely namkin biscuits and its effect on diabetic patients for reducing the Blood sugar level (BSL). Babul bark were dehydrated by tray drying and nutrient estimation of dehydrated babul bark powder was done for protein, fat, ash, moisture, crude fibre, iron, calcium and vitamin-C. Organoleptic test of the product was done by nine point hedonic scale. For intervention 100 respondents aged between 27-80 years were randomly selected from different hospitals of Ramgarh district of Jharkhand and was divided into two groups of 50 each. One was control and the other was experimental. The nutritional status of the patients was recorded through dietary survey. BSL was estimated with alkaline citrate method for both the groups before and after intervention to see the effect of biscuits. The data collected were analysed statistically by using mean, standard deviation, standard error, ANOVA and paired‘t’ test. The nutrient estimation per 100 gm of dehydrated babul bark shows that it is a good source of iron (140mg), fibre (18 g), Vit- C (25.3 mg), and calcium (2939 mg). It is low in fat (2 g) and it contains 58 g carbohydrate in polysaccharide form. A significant difference was found between the color, flavor, texture, taste and over all acceptability of the biscuits enriched with babul bark powder on applying ANOVA test. The mean age of the respondent was 46 years. 87% were non-vegetarian. The energy and fibre intake of respondents in both the groups was less than the RDA. On applying analysis of variance test it was found that there was no significant difference in intake of different nutrients in both the groups. On applying paired‘t’ test a significant difference was found in fasting and PP glucose level of experimental group which was intervened with namkin biscuits enriched with babul bark powder for one month in comparison to the control group. It was concluded that namkin biscuits enriched with babul bark powder was effective in reducing BSL in diabetic patient.

KEYWORDS: BSL- Blood sugar level, PP-Post Prandial, F-BSL- Fasting blood sugar level, ANOVA-Analysis of variance, RDA-Recommended Dietary Allowances.

INTRODUCTION
Babool (Acacia arabica) is commonly known as kikar and bava in Hindi, Indian gum arabic in English, Babula in Sanskrit, Acacia arabica Willd Pennel in Latin. It belongs to the family: Leguminosae, sub-family: Fabacaea. First of all decribed by **Linnaeus in 1773.** The genus acacia was first described by **philipmiller in 1754** and until 1842. It is estimated that there are roughly 1380 species of Acacia worldwide, about two-third of them native to Australia and rest of spread around tropical and subtropical regions of the world. **Gamble, (1918)** have reported more than 40 species of this genus in India in his ‘Flora of Madras Presidency.’

Perennial shrub or tree, 2.5-10 (-20) mtr. tall, variable in many aspects. Branches are spreading, forming a dense

flat or rounded crown with dark to black coloured stems. Bark thin, rough, fissured, deep red-brown. Spines (thorns) thin, straight, light-grey in axilliary pairs, usually in 3-12 pairs, 5-7.5 cm long in young trees, mature trees commonly without thorns. Babul plant is worldwide distributed native to Africa, Algeria, Ethiopia and Ghana. In Asia it is also observed from Iran, Iraq and Israel along with Nepal, Pakistan and India. In India it is widely observed from Rajasthan, Gujarat, Uttar Pradesh, Bihar, Jharkhand, Bengal and Orissa.

Babul tree is of significant importance in Ayurveda, unani medicine and African folk medicine. Babul tree contains Arabinose, Galaclose, Rhamnose and Glucuronic acid. Gum of the tree contains calcium, magnesium and potassium, malic acid, sugar. Bark and pods contain a large quantity of tannins and Gallic acid. (***The Satvik Blog and www.dabur.com***)

Phytochemical investigations of Acacia arabica found that phenolic compounds are presents in Acacia arabica extracts. Acacia arabica contains flavonoids, sterols, triterpenoids, alkaloids and phenolics which possess various health benefits. The isolation and characterization of quercetin, gallic acid, catechin, epicatechin, dicatechin, and leucocyanidin gallate from the acetone extract is reported. The seeds of Acacia arabica contain 5.2% oil. Physico-chemical constants and fatty acid composition of the refined seed oil were estimated. The oil was rich in linoleic acid, oleic acid and trace quantities of epoxy and hydroxy fatty acids. Acacia arabica bark is reported to contain catechin, epicatechin, dicatechin, quercetin, grallic acid leucocyanidin gallate, sucrose and catechin. **(*drugandcure.blogspot.in*)**

The parts of babul such as Leaves, bark and fruit are used beneficial therapeutically. The doses of Babul is Bark decoction 30-80 ml; Bark powder 3-6gm; leaves powder 3-6gm; and fruit powder 3- 6gm. ***(www.avurveda.com)***

It has a slight tan-tike odour, astringent taste and mucilaginous (***botanica.com*)**

Babul is used as anti-diabetic. Acacia arabica seeds contains a substance(s) which depressed the blood glucose level in normoglycemic but not in alloxan-diabetic rabbits, suggesting that the mechanism of action involved release of insulin from pancreatic beta-cells. The bark in the form of decoction (20 mg/kg) as well as the standard drug talbutamide produced a significant reduction in blood glucose levels in mild alloxonised diabetic rabbits fasted for 18 - 38 hr.

Methanolic extract of the bark decreased the UV-induced mutagenicity using the Escherichia coli WP-2 in a dose of 5 mg/plate. This decrease might be due to some enzymatic action which reverted the formation of pyrimidine dimmers.

Acacia seeds extracts displayed more pronounced action on human trypsin and chymotrypsin, it was more effective in inhibiting the total proteolytic activity of the bovine system.

Studies have shown that babul bark extracts resulted in lipid per- oxidation or cholesterol control. On the other hand, the antioxidant properties also showed hepato-protective properties or liver protection from carbon tetrachloride by free radical scavenging.

The seeds of babul can control ordinary diarrhoea, Fresh leaves of the plant can be administered with same quantity of cumin seeds. This mixture of 12g each can be taken thrice every day. The decoction of the gum can be made for the same.

The stem bark extracts of babul or Acacia arabica showed significant antibacterial properties against S. viridans, S. aures, E coli, B subtilis, Sonnei and against fungi such as C albicans, A niger.

The seeds and pod extracts of babul have been shown to significant control the arterial blood pressure. Antispasmodic effects were also observed in the extracts. The antispasmodic effects were very similar to the control of arterial blood pressure.

Babul demonstrated acetyl cholinesterase inhibitory effects. Acetyl cholinesterase inhibition has been named critical in proper functioning of the nervous system and in the treatment of Alzheimer's disease.

Research on babul showed chemopreventive and antimutagenic properties through the presence of polyphenals and gallic acid. The extracts of flowers and gum were observed to be very effective.

For hundreds of years, babul bark and gum have been used for Dental problems. Studies on the babul gum have yielded positive results in removing plaque, gingivitis and periodontitis. The gum was found to be effective in inhibiting the growth of periodontitis bacteria such as Actinobacillus actinomycetemcomitans, Capnocytophaga spp., Porrphyrcmonas gingivalis, Prevotella intermedia and Treponema denticola.

The bark of babul tree is useful in the treatment of eczema. About 25 grams each of this bark and the mango bark should be boiled in about 1 litre of water and the vapours allowed fomenting the affected part. After the fomentation, the affected part should be anointed with ghee.

A decoction of the bark, mixed with rock salt, should be used as a gargle in treating tonsillitis. (***www.dabur.com & www.allayurveda.com***)

The Present study was conducted with following **objectives:**

(i) To process Babul bark in powder form and find out the component changes after dehydration.
(ii) To introduce the babul plant as medicinal uses for reducing the complication of diabetes by preparing biscuits enriched with babul bark powder.
(iii) To assess the organoleptic quality of namkin biscuit enriched with babul bark powder.
(iv) To see the effectiveness of babul bark namkin biscuit on diabetic patient by intervention.

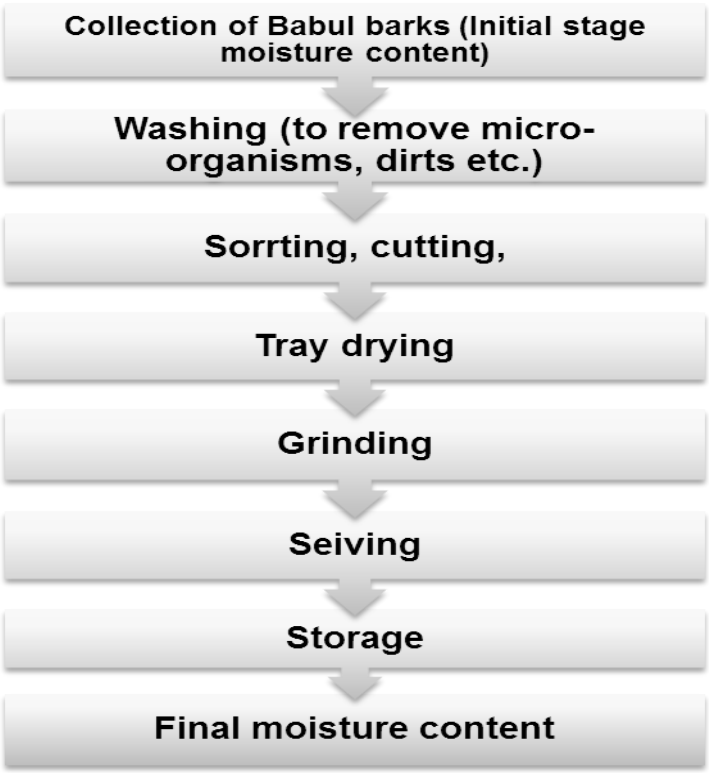
MATERIAL AND METHODS

The present investigation **"UTILIZATION AND NUTRITIONAL EVALUATION OF BABUL (Acacia arabica) FOR THE DEVELOPMENT OF VALUE ADDED PRODUCT TO IMPLEMENT ON THE DIABETIC PATIENT"** was carried out by using the material and methods described in this chapter.

The details of materials, experimental procedure and techniques adopted during the course of the present investigation have been elaborated:

1. **SELECTION OF PRODUCTS:** The product namely babul bark were selected for present study.
2. **PROCUREMENT OF RAW MATERIALS:** Babul (Acacia arabica) barks were collected from local areas of Hazaribag in the month of November to January.
3. **EXPERIMENTAL SITE:** The present investigation was carried out in the laboratory of University department of Clinical Nutrition and Dietetics, Vinoba Bhave University, Hazaribag and Department of Home Science, Birsa Agriculture University, Ranchi.
4. **DEHYDRATION OF BABUL (Acacia arabica) BARKS:** Selected herbal plants namely Babul (Acacia arabica) barks were subjected to dehydration. The Babul (Acacia arabica) barks were tray dried at controlled temperature of 180-200^{0}C for 4-5 hrs.

THE PROCESS IS DESCRIBED IN THE FOLLOWING STEPS



5. **DEVELOPMENT OF VALUE ADDED FOOD PRODUCTS:** rated Babul barks powder were used for the development of value added locally familiar food product namely Namkin biscuits at the ratio of 10:90 in 100 gm.

6. **REPLICATION OF VALUE ADDED FOOD PRODUCTS ENRICHED WITH DEHYDRATED BABUL BARKS WERE DONE AS FOLLOWS**

6.1. CHEMICAL ANALYSIS: Chemical analysis of dehydrated Babul barks powder was done by standard procedures. For this 3 replications were done.

Babul barks	Replication
Dehydrated Babul bark powder	3

6.2. ORGANOLEPTIC TEST: Organoleptic test was done by using 9 point hedonic scale namkin biscuits and it was replicated 5 times.

Product	Replication
Namkin Biscuits	5

7. **ORGANOLEPTIC ANALYSIS OF THE COOKED PRODUCTS:** To analyse the products Namkin Biscuits were freshly prepared and evaluated organoleptically by a panel of five judges selected from the Department of Clinical Nutrition and Dietetics, Vinoba Bhave University, Hazaribag. The judges were requested to score the products with the help of score card based on the nine point hedonic scale; mean scores for biscuits were calculated.
8. **NUTRIENT ESTIMATION:** After estimation - The dehydrated babul bark was analyzed for their moisture content, total ash, protein, crude fibre, crude fat, calcium, iron, carotene. Iron content was estimated by Atomic Absorption Spectrophotometer method. Protein, fat, ash, fibre was estimated by AOAC 1990 method. Calcium was estimated by Atomic Absorption Spectrophotometer. Carbohydrate was estimated by Difference method. Vitamin C was estimated by Dimethod.
9. **CALCULATION OF NUTRITIVE VALUE:** The protein, crude fibre, iron, calcium, carotene, carbohydrate and vitamin-c of the products were calculated by using the proximate analysis values determined of dehydrate babul bark as well as the Food Composition Table by Gopalan et. al. (2004).

FOR INTERVENTION

10. SELECTION OF SAMPLE

Three stages of sampling were adopted for the present study.

(i) SELECTION OF DISTRICT

Ramgarh district was selected purposively for the present study as it was convenient, as the researcher had good access to it, so regular visit could be made authentic for the collection of data.

(ii) SELECTION OF AREA

CCL Hospital of Saunda, Sayal, Bhurkunda and Ramgarh were selected purposively for the study as these are in the centre of the town and were easier for the researcher to make regular visit and carry out the survey.

(iii) SELECTION OF RESPONDENT

The total no of respondents selected were 100, out of whom 50 were in control group & Remaining 50 in experimental group.

Selection was done by simple random sampling method. All the respondents of experimental group were from age group of 27-80 years. Intervented with the biscuits enriched with babul bark powder. Each respondents of experimental group were given 5 biscuits/day (50g) for one month.

11. PREPARATION OF INSTRUMENT A TOOLS FOR THE DATA COLLECTION:

For the date collection a structured schedule was developed. The schedule consisted of the following information which is elaborated below.

(i) GENERAL PROFILE

The data regarding the general profile of respondents were collected using first part of the schedule which include name, age, sex, religion and family type no of family members, total income of the respondents.

(ii) DIETARY SURVEY

In the present study 24 hours dietary recall method (Swaminathan, 2006) was adopted and nutrient intake per day was calculated. Calculation of nutrient intake was done with the help of "Nutritive value of Indian foods". Gopalan ***et. al.*** 2007, and compared with Recommended Dietary Allowances given by ICMR. The food consumption frequency was recorded in terms of cereals, green leafy vegetables and other vegetable, roots and tubers, milk & milk products, meat and fish, egg, fruits, oil & seeds other food (fast and junk food) consumption. Information related to dietary pattern, food habits, food intake and nutrient intake with references to protein, fat, carbohydrate, energy, iron, calcium and fibre were recorded. The respondents were asked to provide information regarding the menu as well as ingredients and amounts used for meal preparation.

(iii) BLOOD TESTING

Blood testing carried out two times in a month of the respondents in both the groups i.e. control group and experimental group. This data was collected for the comparison study.

12. METHOD

Estimation of BSL of both group i.e., experimental and control group were estimated with alkaline citrate method.

13. STATISTICAL ANALYSIS

Data was tabulated and subjected to analysis at the end of the study. The statistical techniques used were as described by **Prasad. S (2012)** and included the following four tests:

1) Standard deviation.
2) Standard Error.
3) Paired t-test
4) Analysis of variance.

14. PERIOD OF INQUIRY

The data for the study were calculated during the period from January - April 2014.

RESULT AND DISCUSSION

Table-1: Proximate composition of dehydrated Acacia arabica bark powder per 100 gm.

Nutrient	Dehydrated Acacia Arabic (babul)			Mean
	R_1	R_2	R_3	
Moisture (gm)	8.360	8.477	8.470	8.435 ± 0.03
Protein (g)	5.33	5.51	5.25	5.36 ± 0.07
Carbohydrate (g)	55.41	56.093	56.30	55.93 ± 0.27
Crude fibre (g)	18.11	18.01	18.14	18.08 ± 0.03
Ash (g)	10.61	10.00	9.91	10.91 ± 0.57
Calcium (mg)	2905.81	2905.8	3006	2939.2 ± 34.0
Iron (mg)	140.5	141.1	141.5	140.86 ± 0.31
Vitamin-C (mg)	20.7	27.6	27.6	25.3 ± 2.34
Fat (g)	2.18	1.91	1.93	2.00 ± 0.08

According to the data obtained from table 1 the proximate composition in response to protein, carbohydrate, fat, vitamin C, Fibre, Iron, Calcium, ash and moisture is in sufficient amount.

After dehydration the moisture content in dehydrated powder was 8 gm, carbohydrate estimation of dehydrate bark was 58 gm which was in polysaccharide form being helpful for diabetic patients. It contain (140 mg) of Iron which can treat the iron deficiency diseases. It is high in fibre content which covers the 18 gm. It is low in fat (2 gm) and high in vitamin-C (25.3 mg). Calcium content in dehydrated babul bark is (2939.2 mg) which can reduce the calcium deficiency.

Table-2: Effect of addition of dehydrated Acica arabica (Babul) bark powder on the colour, texture, flavor and taste of the Namkin Biscuit.

Replication	Sensory scores					Mean ± S.E
	R_1	R_2	R_3	R_4	R_5	
Colour	7.3	8.1	7.9	8.4	9	8.1 ± 0.27
Texture	7.1	7.9	8.4	8.4	9	8.1 ± 0.31
Flavor	7.4	8.1	8.3	8.4	9	8.2 ± 0.25
Taste	7.7	8.3	8.7	8.6	9	8.4 ± 0.21
Overall acceptability	7.9	8.3	8.5	8.6	9	8.4 ± 0.17

RESULT

The table 2 shows average score based on 9 point hedonic scale for colour, texture, flavor, taste, and overall acceptability of biscuit enriched with babul bark powder. Overall acceptability and taste scored maximum followed by flavor, texture and colour respectively.

From the ANOVA **table** it was evident that the calculated value of biscuit was greater than the tabulated value at 5% probability level. Therefore it was found that there was significant difference between the colour, texture, flavor, taste and overall acceptability of the biscuit ($P \leq 0.05$)

So, it was concluded that overall acceptability was overall like to very much.

Table 3: Nutritive value of Namkin biscuit enriched with dehydrated babul bark powder per 100 gm

Sl No.	Ingredients	Energy (K cal)	CHO (gm)	Protein (gm)	Fat (gm)	Iron (mg)	Vit. C (mg)	Fibre (gm)	Calcium (mg)	Moisture (gm)
1	Flour (70gm)	238	48.58	8.47	1.19	3.43	-	1.33	33.6	8.54
2	Bark Powder (10gm)	22	5.593	0.536	0.2	14.15	2.53	1.808	293.92	0.8435
3	Oil (10gm)	90	-	-	10	-	-	-	-	-
5	Milk Powder (6gm)	29.76	2.28	1.548	1.602	0.036	0.24	-	57	0.21

FOR INTERVENTION

All the information about the hundred respondents collected is presented and discussed here. Among the subjects studied majority of the respondents (92%) belonged to Hindu religion whereas (8%) belonged to Muslim religion, (65%) lived in nuclear family whereas (35%) lived in joint family (86%) respondents and his family were literate, earned between Rs. 20,000/- – 25,000/-, had per capita income between Rs. 4,000/- - 5,500/- (47%) were working as government employee and has sedentary life style.

Table- 4. Food consumption frequency of respondents

Food	EXPERIMENT GROUP										CONTROL GROUP									
	Daily		2-4 times a week		4-6 times a week		Seldom		Never		Daily		2-4 times a week		4-6 times a week		Seldom		Never	
	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%	N = 50	%
Cereals and Cereal products	50	100									50	100								
Pulses & Legumes	47	94	3	6							44	88	4	8	2	4				
Green leafy vegetables	43	86	4	8	3	6					38	76	4	8	8	16				
Other vegetables	16	32	13	26	9	18	8	16	4		23	46	11	22	14	28	2	4		
Fruits	36	72	5	10	6	12			3	6	42	84	4	8	2	4				
Milk & its products	48	96			2	4					49	98	1	2						
Meat & Fish			16	28	14	28	11	22	9	18			21	46	17	34	8	16	4	8
Eggs			39	78	7	14			4	8			37	74	11	22			2	4
Other snacks (chips, pakoda)			23	58	6	12	8	16	13	26			14	28	10	20	17	34	9	18
Alcohol			23	46	4	8	12	24	10	222			20	40	12	24	9	18	9	18

Table 4 Showed that, most of the respondents (87%) were Non-vegetarian. Both groups of the respondents were consuming cereals and its products daily. The percentage of consumption of pulses & legumes was higher (94%) in experimental group while higher percentage of respondents in both group consume milk and its product daily. Fruit consumption was very low in both groups (66%) as the comparison of other food consumption frequency.

Table- 5. Average daily Nutrient intake of the respondents in both groups

Group		Energy (Kcal)	CHOs (gm)	Protein (gm)	Fat (gm)	Fibre (gm)	Iron (mg)	Calcium (mg)	Thiamine (mg)	Riboflavin (mg)	Niacine (mg)
Experimental Group	**Intake**	**1566 ± 22**	**196 ± 2.5**	**67 ± 1.44**	**55 ± 1.41**	**6.4 ± 0.14**	**17 ± 0.27**	**856 ± 33**	**1.6± 0.07**	**3.38 ± 0.24**	**16.2 ± 0.56**
	RDA	2320	195	60	25	25	17	600	1.2	1.4	16
	Difference	-754	1	7	30	-18.6	17	256	0.47	1.98	0.2
Control Group	**Intake**	**1564 ± 17.1**	**194 ± 2.73**	**68 ± 1.21**	**57 ± 0.98**	**5.8 ± 0.16**	**17 ± 0.26**	**8.26 ± 10.22**	**1.53 ± 0.07**	**3.41 ± 0.24**	**19.1 ± 0.58**
	RDA	2320	195	60	25	-25	17	600	1.2	1.4	16
	Difference	-756	1	8	37	19.2	0	220	0.33	2.01	3.1
F. Cal. :	**18.51**			**5.12**							
F. Tab. :	**19.00**			**3.63**							
P ≤ 0.05											
Result	**NS**			**NS**							

According to **Table-5** intake of most of the nutrients in the experimental and control groups were comparatively more than the recommended dietary allowance (RDA).

Intake of energy and fibre of both groups i.e., experimental and control were very less than the RDA. On applying analysis of variance (ANOVA) test, it was found that there were no significant differences with respect of all nutrients in different age groups at 5% probability level.

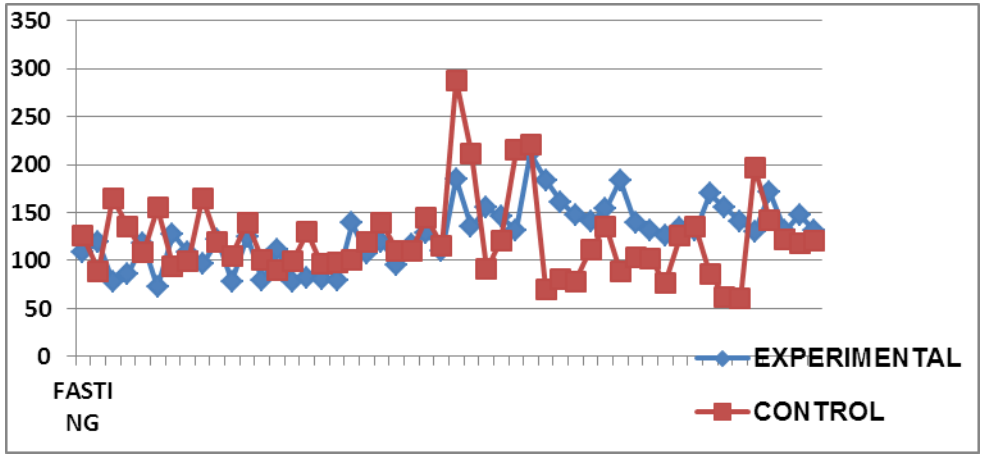


Fig.1. Showed that F.BSL of Control and experimental groups before intervention.

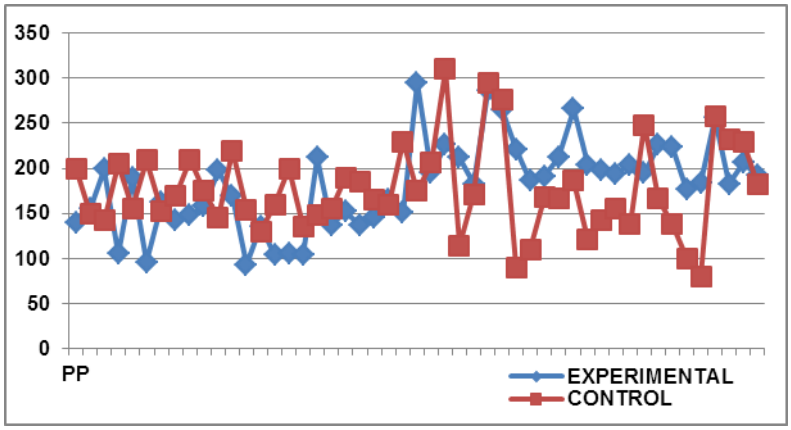


Fig.: 2 Showed that PP of Control and experimental groups before intervention.

Effect on blood glucose level of respondents before intervention of biscuits enriched with babul bark powder

Fasting and PP glucose level of control and experimental group was taken before incorporation of biscuits enriched with babul bark powder. Significant differences of F.BSL and pp was found in both the groups on applying paired 't' test (t.cal of control 2.9 and experimental 4.02) (t. tab. 2.02, d.f. 49, $p \leq 0.05$).

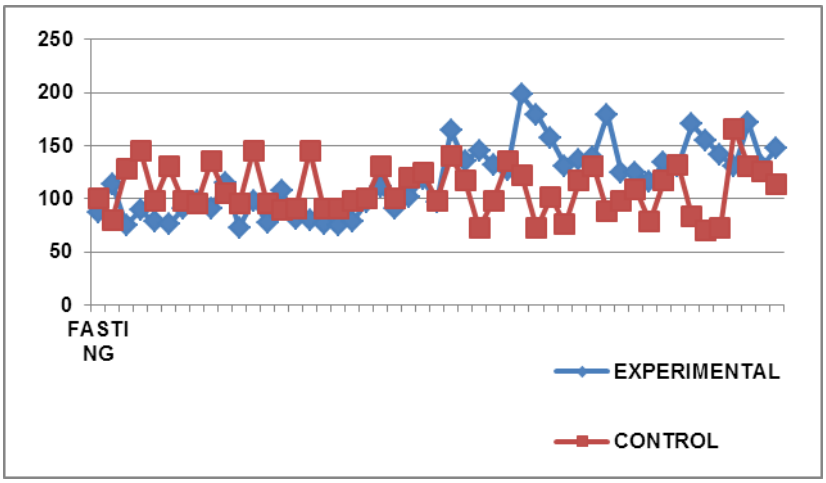


Fig.: 3 Showed that F.BSL of Control and experimental groups after intervention.

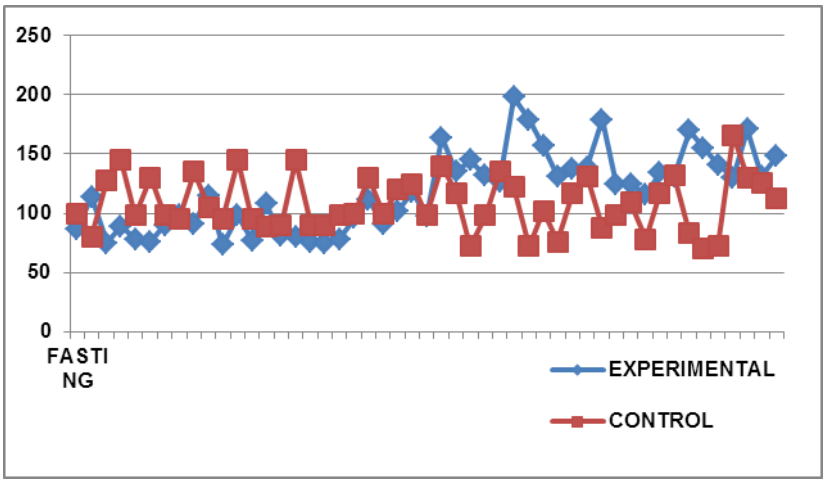


Fig.: 4 Showed that P P of Control and experimental groups after intervention.

Effect of intervention of Biscuits incorporated with dehydrated babul bark powder after incorporation.

Fasting and PP glucose level of control and experimental group was taken after incorporation of biscuits enriched with babul bark powder. Significant differences of F.BSL was found in both the groups on applying paired 't' test (t.cal of control 3.9 and experimental 5.3) (t. tab. 2.02, d.f. 49, $p \leq 0.05$) and pp was also found that

significant differences on applying‘t’ test (t.cal. of control group 2.7 and experimental 5.2) (t.tab. 2.02, d.f. 49, $p \leq 0.05$)

CONCLUSION

It was concluded that babul bark, powder mainly 5 g/day given in the form of namkin biscuit reduces the blood glucose level in diabetic subjects and it may be beneficial for diabetes. This is the primary study, for a short period of time. It may be more effective when more human studies require finding out the effective doses and effect of doses. However nutrition education should also be given for the management and control of disease.

REFERENCES

1. Andreson, A.S., “An overview of diet survey methodology”. British Food Journal 1995; 97. ISS 7.22-26.
2. Banso, A.; “Photochemical and antibacterial investigation of bark extract of Acacia nilotica”. Journal of medicinal plant research, 2009; 3(2): 082-085.
3. Cheema, U.B., Sultan, J.I., Javaid, A., Akhtar, P., and Shahid, Mr.,; “Chemical composition, mineral profile and in situ digestion kinetics of fodder leaves of four native etrees, Pakistan J. Bot., 2011; 42(1): 397-704.
4. Chellapandian, M., and Murugan, M., “Chemical composition and nutritive value of Acacia nilotic pods for sheep. Indian J. small rumin, 2003; 9(2): 130-132.
5. Durry. H.C., “Ayurvedic useful plants of India, with their medicinal properties and use in medicine”. Article published by Colonel Herber Durry. 2006.
6. FAO Gum arabic (Published in FAO food and nutrition paper 49, 1990) 1992,PP 735 – 737. In compendium of food additive specification. FAO food & Nutrition paper 52 (Joint FAO/WHO) Expert committee on food Additive, Food & Agriculture organizati
7. Goels, S., and Kaur, T.,; “Impact of Hypoglycemic herbal mixture based biscuits intervention on blood glucose level and lipid profile of Type 2 DM.”. 2012, IJFANS: E ISSN 2320-7876
8. Jensen. C.D., Spiller, G.A., and Gates, J.E. ;“The effect of acacia gum and a water soluble dietary fiber mixture on blood lipids in human”. J. Am. Coll. Nutr. 1993; (2): 147-154.
9. Khan, M.A., Khan, T., and Ahmed, Z., “Barks used as source of medicine in Madhya Pradesh, India”. Fitoterpia, 65:444-446.
10. Masuellie & Martin A., “Hydrodynamic properties of whole Arabic gum” American Journal of Food Science and Technology. 2013; 1.3, 6.
11. Pradeep, A.R., Agrwal, E.P., Bajaj, S.B., Naik, N., Shanbhag, and Uma, S.R., “Clinical and microbiolgic effects of commercially available gel and powder containing Acacia arabica on gingivitis”. Australian Dental Journal, 2012; 57: 312-318.
12. Priyanka, P., and Maya. C., “Management of type 2 DM by Indian gum Arabic pods powder”. International Journals of Food & Nutritional Search. 1994:, e-ISSN: 2320-7876 Col.-2 ISS – 2, April – June(2013).
13. Rajvaidhya, S., Nagori, B.P., Singh, G.K., Dubey, B.K., Desai, P., and Jain, S.;“A review on Acacia Arabica – An Indian Medicinal Plant”. 2012, International Journals of Pharma and Science Research, 3(7): 1995-2005.