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Proximate Composition, available Carbohydrates, Dietary Fibres and Anti-Nutritional factors in BAEL *(Aegle Maemelos L.)* Leaf, Pulp and Seed Powder

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Abstract- Bael (*Aegle marmelos* L.) leaf, pulp and seed powder were analyzed chemically for proximate composition, available carbohydrates, mineral content, dietary fiber and anti-nutritional factors. The values have been calculated for 100 g of bael (*Aegle marmelos* L.) leaf, pulp and seed powder. It was found that bael leaf, pulp and seed are good source of protein, fat, minerals, crude fibre and energy. They are rich source of available carbohydrates and dietary fibre. They also contain anti-nutrient content which help in controlling blood sugar. Thus, it was concluded that this hypoglycemic medicinal plants provide various nutrients which are not provided by allopathic medicine and these plants have no side effects. So, the diabetic patients should be encouraged to include this medicinal plant in their daily diet to control blood sugar level.

Index Terms- Crude fat, crude protein, Saponin, Tannin and Phytic acid

I. INTRODUCTION

Aegle marmelos family rutaceae is highly reputed medicinal tree commonly known as the bael. It is medium sized tree growing throughout the forest of India of altitude 1200 meter. It is found all over India, from sub-Himalayan forest, Bengal, central and south India. The different parts of this plant contain number of coumarins, alkaloids, sterols and essential oils. Various parts of this plant such as leaves, fruit and seed possess hypoglycaemic, hypolipidemic and blood pressure lowering property (Lmbole et al 2010). The peel of the fruit which is a very hard shell and green to brown in color depends on ripening stage. The appearance of yellow or orange edible pulp is like a boiled pumpkin, possesses a slightly sweet taste and a characteristic floral, terpene-like aroma, very fragrant and pleasantly flavored. Seeds are surrounded by slimy transparent mucilage (Suvimol and Pranee 2008).

Bael (*Aegle marmelos*) is an important medicinal plant of India. Biochemical compounds of bael leaves, fruits and seeds have been used in several diseases like diabetes, cardiovascular and anti-inflammatory (Maity et al 2009). The most important ingredients present in plants are alkaloids, terpenoids, steriods, phenols glycosides and tannins (Venkatesan et al 2009). The bael leaf contain seven monotorpene hydrocarbons (90.7%), three oxygenated monoterpenes (2.9%), four sesquiterpene hydrocarbons (3.1%) and one phenolic compound (0.2%). Limonene (82.4%) was the main constituent of bael (Kaur et al 2006). *Aegle marmelos* leaf extract (200 mg/dl for 35 days) significantly affect the activity of lipid peroxidase, lipoprotein and antioxidant enzymes in isoproterenol treated rats (Rajadurai and Prince 2005).

Leaf extract of *Aegle marmelos* (Bilva) was effective in restoring blood glucose, body weight to normal values and significantly reversed the altered (histological and ultra structural) parameters in tissues of streptozotocin induced diabetic rats seen by light and electron microscopy to near normal and improved the functional state of pancreatic beta cells. The hypoglycemic effects of this plant drug appear to be mediated through regeneration of damaged pancreas (Dahanukar et al 2000). Bael leaf enhances ability to utilize the external glucose load in the body by stimulation of glucose uptake similar to insulin. Bael extract significantly lowers blood urea, reduction in lipid peroxidation and cholesterol and increased levels of super dioxide dismutase, catalase, glutathione peroxidase and glutathione level in serum as well as in liver in experimental diabetic animals (Sharma et al 2007).

These days great attention is being given to management of diabetes with medicinal plants along with dietary restriction. Modern medicine is rooted in ethno botanical traditions using indigenous flora to treat symptoms of human diseases or to improve specific aspects of the body conditions. Today a great number of modern drugs are still derived from natural sources and 25 per cent of all prescriptions contain one or more active ingredients from plants (Thorfeldt 2005). WHO has estimated that 80 per cent of the population of developing countries still relies on traditional medicines mostly plant drugs for their primary health care needs and ensure patient safety by upgrading the skills and knowledge of traditional medicine providers (WHO 2008).

The prevalence of diabetes has dramatically increased in the latter half of the the 20th century, largely due to ready availability of large quantities of calorie rich foods and the technology driven reduction in routine daily exercise (Birnbaum 2005). Obesity and physical inactivity independently contribute to the development of type-2 diabetes. However, magnitude of risk contributed by obesity is much greater than that imparted by lack of physical activity (Rana et al 2007).

Bael leaves taken every morning reduce blood pressure due to presence of potassium which maintain dialation of blood vessels (Parichha 2004). Aegeline 2 present in leaves of *Aegle marme*los

have antihyperglycemic activity as evidenced by lowering the blood glucose levels, decreased the plasma triglyceride, total cholesterol and and free fatty acids accompanied with increase in HDL-C and HDL-C/TC ratio (Narender et al 2007). Clinically bael leaves also show antidiabetic activity (Yaheya and Ismail 2009). Bael patra is used in management of hyperglycemia where the sugar level in blood and urine reduced significantly by the end of 8^{th} week (Shankhla et al 2009).

II. METHODOLOGY

The raw material, bael leaves and fruit were procured from Regional Research Station, Patiala. Fresh leaves were thoroughly washed to remove unwanted material and dirt. The leaves were spread under shade for drying and then dried in oven at 40^0C for 4-6 hours. Dried leaves were powdered. Fresh bael fruit were thoroughly washed in clean water to remove unwanted material and dirt. The washed mature bael fruit were broken and pulp along with the seeds and fibre were scooped out. Then they were mixed properly and pulp was separated from the fibre by pulper. Bael fruit powder were prepared by drying the pulp after adding 2 g/kg sodium carbonate in the form of thin layer, this layer were cut into pieces and further dried to below 4 per cent moisture in a cabinet drier at 60 ± 5^0C. The pieces were grinded into powder. Bael seeds were washed in clean water to remove dust. The seed kernel were dried in an oven at 60 – 65^0C till complete drying and then ground into fine powder by 60 mesh sieve size in a cyclotic mill and were stored in air tight plastic container for further use. Bael leaf, fruit and seed powder will be analyzed chemically for proximate composition (AOAC 1990), available carbohydrates (Yemen and Willis 1954, Somogyi 1945 and Clegg 1956), mineral content (Page et al 1982 and AOAC 2000), dietary fiber (Van Soest and Wines 1967) and anti-nutritional factors (Singh and Jambunathan 1981, Fenwick and Oakenfull 1983 and Sadasivam and Manickam 1992).

Statistical analysis: The data on proximate composition, available carbohydrates, mineral content, dietary fiber and anti-nutritional factors were analyzed statistically. The average and mean standard error was ascertained using a computer programme package (Cheema and Singh 1990).

III. RESULTS AND DISCUSSION

Bael (*Aegle marmelos* L.) leaf, pulp and seed powder had 66.5±0.46, 61.6±0.07 and 49.1±0.12 g of moisture respectively, 5.9±0.12, 4.7±0.13 and 1.9±0.14 g of crude protein respectively, 1.8±0.10, 0.5±0.06 and 13.1±0.07 g of crude fat, 14.8±0.13, 6.5±0.12 and 5.3±0.07 g of crude fiber, 9.2±0.03, 2.7±0.11and 3.0±0.12 g of ash, 1.8±0.09, 24.1±0.08 and 27.6±0.14 g of carbohydrate and provided 47.0±0.53, 119.8±0.55 and 235.9±0.09 Kcal of energy respectively. Narendhirakannan et al (2005) reported that *Aegle marmelos* leaf powder have 10.3 g ash. According to Gupta et al (2006) bael pulp contain 61.5% moisture, 0.3% fat, 1.8% protein, 2.9% fibre with 137 Kcal calorific value (Table 1).

Table 1: Proximate composition of bael (*Aegle marmelos* L.) leaf, pulp and seed powder

	Bael Leaf (g/100g)	Bael Pulp (g/100g)	Bael Seed (g/100g)
Moisture	66.5±0.46	61.6±0.07	49.1±0.12
Crude Protein	5.9±0.12	4.7±0.13	1.9±0.14
Crude Fat	1.8±0.10	0.5±0.06	13.1±0.07
Crude Fiber	14.8±0.13	6.5±0.12	5.3±0.07
Ash	9.2±0.03	2.7±0.11	3.0±0.12
NFE	1.8±0.09	24.1±0.08	27.6±0.14
Energy (Kcal)	47.0±0.53	119.8±0.55	235.9±0.09

Bael (*Aegle marmelos* L.) leaf, pulp and seed powder had 4.3±0.12, 7.6±0.18 and 6.6±0.09 g of total sugars, 2.9±0.06, 6.2±0.09 and 0.4±0.06 g of reducing sugars, 1.4±0.09, 1.4±0.11 and 6.2±0.12 g of non-reducing sugars and 1.3±0.12, 3.6±0.14 and 3.1±0.13 g of starch respectively (Table 2).

Table 2: Available carbohydrates of bael (*Aegle marmelos* L.) leaf, pulp and seed powder

	Bael Leaf (g/100g)	Bael Pulp (g/100g)	Bael Seed (g/100g)
Total soluble sugars	4.3±0.12	7.6±0.18	6.6±0.09
Reducing sugars	2.9±0.06	6.2±0.09	0.4±0.06
Non reducing sugars	1.4±0.09	1.4±0.11	6.2±0.12
Starch	1.3±0.12	3.6±0.14	3.1±0.13

The concentrations of zinc in bael (*Aegle marmelos* L.) leaf, pulp and seed powder was 6.5±0.06, 3.0±0.09 and 6.0±0.10 mg ; chromium 19.5±0.20, 16.6±0.06 and 7.8±0.07 mg and iron 22.5±0.21, 8.0±0.24 and 16.6±0.26 mg respectively. Narendhirakannan et al (2005) reported that *Aegle marmelos* leaf powder contained 0.14 µg zinc, 2.67 µg iron and 1.73 µg of chromium (Table 3).

Table 3: Mineral content of bael (*Aegle marmelos* L.) leaf, pulp and seed powder

	Bael Leaf (mg/100g)	Bael Pulp (mg/100g)	Bael Seed (mg/100g)
Zinc	6.5±0.06	3.0±0.09	6.0±0.10
Chromium	19.5±0.20	16.6±0.06	7.8±0.07
Iron	22.5±0.09	8.0±0.12	16.6±0.11

Bael (*Aegle marmelos* L.) leaf, pulp and seed powder had 30.0±0.47, 12.0±0.28 and 12.0±0.09 g of neutral detergent fiber, 26.0±0.12, 12.0±0.28 and 4.0±0.14 g of acid detergent fiber, 4.0±0.09, 0.0 and 8.0±0.07 g of hemicellulose, 2.0±0.06, 2.0±0.03 and 6.0±0.09 g of cellulose, 24.0±0.09, 8.0±0.12 and 6.0±0.12 g of lignin and 3.4±0.29, 8.8±0.26 and 5.8±0.27 g of pectin respectively. Suvimol and Pranee (2008) reported that thai bael fruit pulps had total, soluble, and insoluble dietary fiber contents of 19.84, 11.22, and 8.62 g/100 g, respectively (Table 4).

Table 4: Dietary fiber constituents of bael (*Aegle marmelos* L.) leaf, pulp and seed powder

	Bael Leaf (g/100g)	Bael Pulp (g/100g)	Bael Seed (g/100g)
Neutral detergent fiber	30.0±0.47	12.0±0.28	12.0±0.09
Acid detergent fiber	26.0±0.12	12.0±0.28	4.0±0.14
Hemicellulose	4.0±0.09	0.00	8.0±0.07
Cellulose	2.0±0.06	2.0±0.03	6.0±0.09
Lignin	24.0±0.09	8.0±0.12	6.0±0.12
Pectin	3.4±0.29	8.8±0.26	5.8±0.27

Bael (*Aegle marmelos* L.) leaf, pulp and seed powder had 2.3±0.11, 9.0±0.17 and 1.6±0.20 g of tannin, 3.7±0.12, 1.2±0.32 and 0.6±0.12 g of saponin and 0.6±0.14, 0.4±0.19 and 1.9±0.21 g of phytic acid respectively. According to Agroforestry Database (2009) reported that bael pulp contain 9% tannin (Table 5).

Table 5: Anti-nutritional factors of bael (*Aegle marmelos* L.) leaf, pulp and seed powder

	Bael Leaf (g/100g)	Bael Pulp (g/100g)	Bael Seed (g/100g)
Tannins	2.3±0.11	9.0±0.17	1.6±0.20
Saponin	3.7±0.12	1.2±0.32	0.6±0.12
Phytic acid	0.6±0.14	0.4±0.19	1.9±0.20

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