2011 International Conference on Food Engineering and Biotechnology
IPCBEE vol.9 (2011) © (2011)IACSIT Press, Singapore

Biochemical Composition of Soibum – A Fermented Bamboo Shoot and Its Dynamics During Fermentation in Real Time Model

H. Dayanidhi Singh[1], S. Anil Singh[1], N. Robbarth Singh[2] and N. Rajmuhon Singh[1]*

[1] Department of Chemistry, Manipur University, Canchipur – 795003

[2] Department of Food Engineering, I.I.T, Kharagpur, West Bengal

Abstract. The goal of this investigation was to evaluate the chemical composition of *Soibum,* fermented bamboo shoot commonly consumed in north east part of India with special reference to its nutritional point of view. Comparison was made between two types of *Soibum* viz. Kwatha and Andro types in all aspects of analysis. Besides all the proximate constituents, vitamins (ascorbic acid and riboflavin) and fatty acids (saturated, mono-saturated, poly-saturated and trans- fatty acids) were determined with the standard procedures. Major and trace elements were also able to be determined by EDXRF; prominent elements determined include K, P, Ca, Cl, etc. From the data, *Soibum* was found to be a good source of dietary fibre.

Keywords: Bamboo shoot, Soibum, fermentation, EDXRF

1. Introduction

Bamboo shoot is a food item consumed either as fresh or processed forms. It is a plant which is widely distributed and grows wild in the fields and mountains from the temperate zone of Japan to the tropical zone of India. For centuries, fermented bamboo shoots have lent unique flavors and a distinctive crunchy texture to traditional Asian dishes. They are often combined with other ingredients such as ginger, garlic, bell paper, white sesame and red chilli and then stir fried with leak, scallions, poultry, stock and anise to make soup. [1] In Manipur, a state located in the north eastern part of India, bamboo shoot is consumed as fresh or fermented. Fermented form, locally called *Soibum*, is a highly prized item and its consumption dates back time immemorial. There are classically two main types differing in their mode of fermentation; Andro type and Kwatha type. They have their unique taste and texture.

Organic acid, sugar, amino acid and vitamin composition of bamboo shoots were reported. The major organic acids in bamboo shoot ranged from 462 (top) to 157 mg (base) per 100 gm fresh weight. Citric acid was rich in the upper half, while malic acid was rich in the lower $3/4^{th}$. Fructose, glucose and sucrose were contained with approximately equal amounts in the top quarter section, the former two sugars were abundant in the lower half.[2] Total lipids ranged from from 800 (top) to 380 mg (base) per 100 gm fresh weight. The main fatty acids of the three lipid classes were palmitic, linoleic and linolenic acids.[3] The apical portion was richest in vitamin C and dehydroascorbic acid while in the internodal joints and the basal portion was richest in vitamin C. [4]

Studies were conducted on changes in nutrient composition and sensory properties of *Bambusa tulda* shoots during traditional fermentation process. Reports of analysis of nutrient contents of edible bamboo are limited. [5] Even more, studies on fermented bamboo shoot are rather scanty.

*Corresponding author. Tel.: + 919436080780, Fax: +91-385-2425145
E-mail address: rajmuhon@yahoo.co.in

Our research aims to find out the nutritional content and also to analyze the biochemical changes occurring during fermentation. Taking into consideration that bamboo is the fastest growing plant and rampant malnutrition in the developing countries, our study is imperative.

2. Materials and Methods

2.1. Materials

Two primary production sites, based on pedigree analysis, of *Soibum* were selected. In each site again, three spots/ vessels were randomly selected. From each vessel production spots, sample was collected every week starting time = 0 i.e freshly sliced sample before keeping for fermentation. The collected samples were packed in 500 ml coded PET bottles and transported and stored in the laboratory refrigerator for further analysis.

The first production site is situated about 60 km from the laboratory, Kwatha (N 24˚ 19', E 94˚16', 450 msl) and second production site is located about 25 km from the laboratory, Andro (N 24˚ 19', E 94˚16', 450 msl). The raw materials used in both model (**Kw**, Kwatha and **As**, Andro) was *Bambusa balcooa* (*Local Name: Ching Saneibi*). Andro model uses earthern pot with holding capacity of around 50 L. It is a fed batch fermentation system where the raw materials are added per week for three to four times. Kwatha model uses a large bamboo basket lined with plastic on its wall and at the bottom. Exudate can leach out from the leaked areas. Leaves were said to be used before the advent of plastic.

2.2. Methods

Proximate chemical composition including protein [6], fat [7], crude fibre [8], reducing sugar [9], fatty acid profile like saturated fat, monounsaturated fat, polyunsaturated fat and trans fatty acid [10] were determined adopting the standard procedure. Moisture was determine by oven drying method, minerals by ashing in muffle furnace and carbohydrate by difference method.

Elements (trace and major) were estimated by EDXRF (Energy Dispersive X-ray fluorescence) spectrometer; model ERWIN-3600 with a silicon drift chamber and semi-conductor. The sample collected were first cleaned and dried. The dried sample was crushed using agate mortar. About 200 mg crushed samples were made into pallets, 13 mm diameter and 3 mm thick, using a hydraulic press and subsequently used as targets. Five replicates of each target were prepared. A pallet of the NIST Apple Leaf Standard (SRM) was also prepared in the same way.

3. Results and Discussion

3.1. Proximate composition

Proximate composition, as determined, consists of moisture, dry matter, crude protein, ash, crude fibre, crude fat and carbohydrate (sugar). The proximate composition and gross energy of the two types of samples are given in table IA. The average moisture content of the two samples **Kw** and **As** were 91.5 and 90.73 % respectively with respective standard deviation of 1.83 and 0.71%. This indicates high moisture content of the samples. **As**, however, contains slightly higher moisture on the average of about 1.17 %. Dry matter therefore, is in the range of 7 -10%. Crude fibre and protein are found to be in the range of 2 – 3%. Crude fibre is defined as insoluble carbohydrate composed of cellulosic, hemicelllulosic and ligneous matter. **As** contains relatively higher quantity i.e. 3.54 and 3.09 % respectively for protein and fibre. However, consistent result was found in **Kw** sample showing respective standard deviation of 0.41 and 0.58 %. Crude fat is higher in case of **Kw** (0.6%) compared to **As** (0.35%). Sugar is slightly higher in **Kw** (2.01%) while **As** has about 1.84%.

Comprehensive study on dietary fiber and other components of fruits and vegetable was conducted. Neutral detergent fibre of most samples was found to be between 0.9 – 1.2 %. Sample analysed include pineapple, carambola, sapodilla, papaya, mango, grapefruit, sweet potato and yam. [11] Compared to this data range, *soibum* seems to contain higher amount of fibre. The average fibre content of the two samples analysed viz. Kw and As were 2.61 and 3.09%. Thus, *soibum* is a good source of dietery fibre. In another study dried bamboo shoot was found to contain around 29.3% neutral detergent fibre (NDF). [12] In-vitro test revealed that most NDF can bind more dihydroxy acids than trihydroxy acids. Bamboo shoot exhibited good binding capacity. However, its fermented form, *Soibum*, still needs o be investigated. Many studies have demonstrated that dietery fibre is a very important beneficial substance for decreasing serum and/ or hepatic lipids, especially cholesterol.[13]

Energy content was calculated on the basis that 1 gm each of sugar, fat and protein are equivalent to 4, 9 and 4 Kcal respectively. The mean energy content of both the samples was remained approximately same (22.44 and 24.66 % for **Kw** and **As** respectively).

Estimated saturated fat, mono-saturated, poly-unsaturated and trans fat are shown in the table I. b. The two samples showed no significant difference in mono saturated and poly unsaturated fat but **Kw** showed slightly higher amount of saturated fatty acid (0.31%) as compared to **As** (0.18%). Absence of trans fatty acid indicates its safety for human consumption. Estimated ascorbic acid and riboflavin were shown in table I. c. Content of Vit. C is higher than many fruits and vegetables. Concentration of ascorbic acid and riboflavin in both the samples are similar and showed little differences. Though the concentration of riboflavin is small, it may provide significant role in human health.

3.2. Elemental Analysis

EDXRF analysis of the product sample revealed presence of number of elements (table 1. d.). Potassium is exceptionally higher in both the samples about 34127.5 ± 3.55 in **Kw** and 29551 ± 10.5 ppm in **As**. P, S, Cl and Ca are also present high amount. Eighteen numbers major and trace elements concentration were given table 1b. To our knowledge, this is the first time, elemental analysis was done by EDXRF in *Soibum*. It can be corroborated from the data that *soibum* is a good source of minerals.

3.3. Changes in Reducing sugar and Acidity

Reducing sugar like glucose is the most important substrate for microbes to undergo fermentation. Understanding the dynamics of reducing sugar will also enable to understand the fermentation mechanism. An interesting observation was found in the Kwatha (**Kw**) and Andro (**As**) model. In Kw, a sharp and consistent decrease in the concentration is found (Fig. 1). On the contrary, **As** showed zig-zag pattern (Fig. 1), concentration suddenly decrease in the first 10 days and again shoot up. This happened for number of times as long as new substrate was added. However, an average trend indicates decrease over a period of time. It fits average trend of decrease. On the other hand, decrease in concentration of reducing sugar in kwatha model seems to obey a certain uniform trend.

Acidity was measured on the basis of lactic acid. Increases in the acidity concentration were shown on both the fermentation model Fig. 2 and 3. However, distinct differences were observed in the behavior and pattern in their changes over time. On the day to day basis, **As** rise its acidity more steeply than **Kw**.

4. Conclusion

It was observed from the analysis that *Soibum* is a potential source of dietary fibre. Low content of lipid and absence of trans fatty acid also indicated its health promoting nature. Elements like K, Na, Cl, Mn, Cu, etc. were present in significant quantity. Fermentation also showed to reduce the amount of reducing sugar to a great extent converting them to acid. Therefore, acidity rises up until reducing sugar bio-conversion get exhausted.

5. Acknowledgement

We are thankful to Department of Biotechnology, Govt. of India for financial assistance.

6. References

[1] Shih-Guei Fu, Youngmo Yoon, Russell Bazemore. Aroma-active components in fermented bamboo shoots. *Journal of Agricultural and Food Chemistry*, 2002, **50** (3), 549-554

[2] Etsuko Kozukue, Nobuyuki Kozukue & Toshiharu Kurosaki. Organic Acid, Sugar and Amino Acid Composition of Bamboo Shoots. *Journal of Food Science,* 1983, **48**, 935 - 938.

[3] Etsuko Kozukue & Nobuyuki Kozukue. Lipid Content and Fatty Acid Composition in Bamboo Shoots. *Journal of Food Science*, 1981, **46**, 751-755.

[4] Y. Kitagawa, *Journal of the Japanese Society of Food and Nutrition.* 1971 **24** (8), 449 – 451.

[5] Alka Bhargava, Vishakha Kumbhare, Anubha Srivastava & Amit Sahai. (1996). Bamboo Parts and Seeds for Additional Source of Nutrients. *Journal of Food Science and Technology*. Vol. 33, no. 2, 145-146

[6] O.H. Lowry, N.J. Rosebrough, A.L. Farr, and R.J. Randall. Protein Measurement with the Folin Phenol reagent. *Journal of Biological Chemistry.* 1951, **193**, 265 -275.

[7] J. Folch, M. Lees, & G.H.S. Stanley. *Journal of Biological Chemistry*. 1957, **226**, 497

[8] G.L. Bidwell, & L.E. Bopst. *Journal of the Association of Official Analytical Chemists*. 1922. **5**, 98

[9] N. Nelson. *Journal of Biological Chemistry.* 1944, **153**, 375

[10] AOAC. "Official Methods of Analysis", 13th ed.; *Association of Official Analytical Chemists*; Washington DC, 1980

[11] Eric Lund & John Smoot. *Journal of Agricultural and Food Chemistry.* 1982, **30**, 1123 – 1127

[12] M.L. Chen, S.G. Chang, & J.Y. Guoo, J. Y. *Nutrition Reports International.* 1982, **26** (6) 1053 – 1059.

[13] E. Tsai. Chingmin. *Food Science.* 1997, **24** (6) 706 – 71

Figure captions

Fig.1. Reducing sugar changes during the course of fermentation in Kwatha (----) and Andro (——) type.(——) indicates trendline. Values of reducing sugar are in microgram/gm.

Fig.2. Acidity (percentage total acid) changes during the course of fermentation in Kwatha type. (◆—) indicates actual curve. (——) indicates linear trendline.

Fig.3. Acidity (percentage total acid) changes during the course of fermentation in Andro type. (◆—) indicates actual curve. (——) indicates avg. trendline

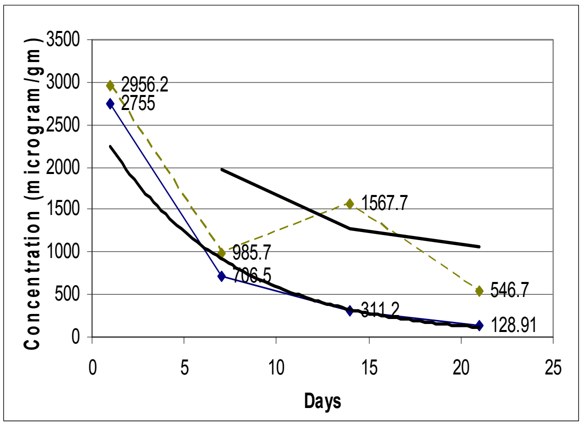

Fig.1

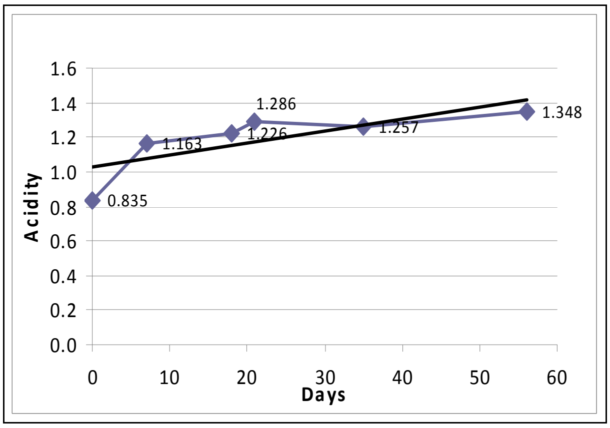

Fig.2

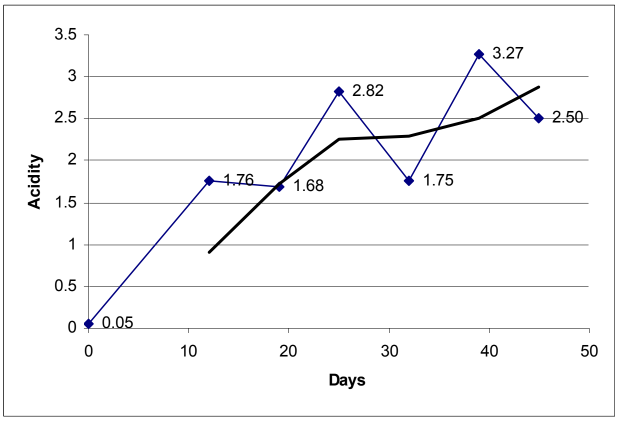

Fig.3

Table I. a. Proximate composition (g/ 100g) and gross energya of Soibum (fermented bamboo shoot)

[a] Energy in kilocalorie per 100 gm
[b] SD Standard deviation.

Spots (Kw)	**Moisture**	**Dry matter**	**Crude Protein**	**Crude fibre**	**Ash**	**Crude fat**	**Sugar**	**Energy**
1	93.10	6.9	2.29	2.21	0.4	0.53	1.47	19.81
2	89.50	7.5	2.94	2.35	0.56	0.71	3.94	33.91
3	91.90	8.1	3.04	3.28	0.61	0.55	0.62	19.59
Mean	91.50	7.50	2.76	2.61	0.52	0.60	2.01	24.44
SD[b]	1.83	0.60	0.41	0.58	0.11	0.10	1.72	8.20
Spots (As)								
1	91.5	5.5	2.11	2.33	0.48	0.42	3.16	24.86
2	90.1	9.9	4.8	3.37	0.32	0.25	1.16	26.09
3	90.6	6.4	3.7	3.57	0.55	0.38	1.2	23.02
Mean	90.73	7.27	3.54	3.09	0.45	0.35	1.84	24.66
SD[b]	0.71	2.32	1.35	0.67	0.12	0.09	1.14	1.55

Fatty acids	Kw	As
Saturated fat	0.31	0.18
Mono-saturated fat	0.05	0.03
Poly-unsaturated fat	0.17	0.1
Trans fat	0	0

Table I. b. Fatty acids profilea
[a] Values are in % wet wt. basis

Vitamins	Kw	As
Ascorbic acid	174.7	170.17
Riboflavin	11.23	13.55

Table I. c. Contents of vitamins (microgram /gm)a
[a] Values are in wet wt. basis

Table I. d. Mineral concentration[a] (in ppm)

Sl. No.	Element	Kw	As
1	P	3540.5±2.12	3005.1±5.1
2	S	2782±4.24	2859.5±3.9
3	Cl	6944.5±3.54	7455.3±10.5
4	K	34127.5±3.55	29551.2±6.7
5	Ca	1283.5±2.13	1463.8±2.3
6	Rb	104.25±0.07	65.1±3.7
7	Mn	85.11±0.54	91.2±0.67
8	Zn	47.08±0.61	37.4±0.55

Sl.No.	Elements	Kw	As
9	Cu	12.03±0.4	15.8±0.9
10	Br	16.72±0.56	19.33±1.2
11	Sr	6.63±0.42	2.6±0.56
12	Fe	219.3±4.9	189.4±5.7
14	Cr	2.29±	1.6±0.05
15	V	0.49±	0.25±0.07
16	Co	0.12±	0.05±.01
17	Se	0.48±	1.2±.08
18	Pb	0.13±	0.47±0.1

[a] Mean value of three spots. Values in dry basis.