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Evaluation of Nutritional Quality Parameters of Silk Worm Breed (Multivoltine & Bivoltine Breed) in Multi-Purpose Solar Tunnel Dryer

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ABSTRACT

Silkworm Pupae are the by-product of the silk reeling industry, which can generate additional revenue for the reeling entrepreneurs with effective management and utilization. In some parts of India and China, the silkworm pupae are regarded as delicious food and are extensively used. Two breeds of silkworm pupa are majorly discarded from reeling industry v_{iz}*. PM X* CSR_2*,* CSR_2 *X* CSR_4*. Present investigation found that there was no significant differences in the nutritional value between the two hybrids* CSR_2 *X* CSR_4 *and PM X* CSR_2*. The average percentage of total protein and fat contents of breeds* CSR_2 *X* CSR_4*, PM X* CSR_2 *were 49.44%, 48.23% and 29.93%, 30.30% respectively*

Key words: *Post harvest processing, Solar tunnel dried, Silkworm, Pupae*

INTRODUCTION

The Silk industry has a distinctive position in India, and plays a significant role in textile industry and export. India is the second largest producer of silk in the world with 28523 MT and contributes 20 % of the total world raw silk production. (CSB report 2015-16). Silkworm pupae are the major by-products of silk reeling industries obtained after reeling. Silkworm pupae have been found to be a rich source of protein. They are a good source of animal protein in place of fish meal in animal feeds. There is a need to tap the potentiality of silkworm pupae for socio-economic development of rural and urban population. Fats and oils collectively termed as lipids are in great demand for food and non-food. About 90% of this is used in production of soap and other surface-active compounds and the balance is used for other industrial purposes. It appears that silkworm pupae have a high dietary value, much more than fish and other animal proteins and on par with meat from various animal sources. The fleshy larvae, prepupae and pupae of non-mulberry silkworms such as muga, tasar and eri are preferred as food by Garo, Mikir and Khasi tribes of India. They are in high demand in local markets of North-Eastern states. (Savithri and Sujathamma).

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Proximate analysis of pupae showed that it contains 55-60% protein, 25- 30% lipid, 4.96% fibre and other substances e.g. hormones, trace elements, and vitamins, thus indicating that it could be a good protein[11]. Pharmacological studies show that silkworm pupae are alimental for increasing immunity, protecting the liver and preventing cancer. Consumption of silkworm pupae could supplement Vitamin B2 intake, which can be important to prevent the serious effects of Vitamin B2 deficiency[4]. One piece of silkworm pupa contains 18 kinds of amino acids, and 8 of them are essential amino acids for human beings (14.59% of total protein and 40% of total amino acids[6]. The human body needs eight kinds of human essential amino acids absorbed from food, their contents in silkworms are two times higher than those of pork and four times than those of egg and milk. Pupae protein is a complete protein and the amino acids compositions are with appropriate proportions in line with FAO/WHO standards[2,10].

Currently two major types of commercial hybrids CSR_2 X CSR_4 and PM X CSR_4 are reeled at reeling industries. Literature survey revealed that there are no comparative study for proximate analysis, amino acid of CSR_2 X CSR_4 and PM X CSR_4 hybrid which can be used for poultry industry. Hence it was the major goal of this study to investigate if there is any difference in the nutritional value of these two hybrids.

MATERIAL AND METHODS

Sample Preparation

Raw silkworm pupae were collected from a reeling center in Chintamani and Shidlagatta taluka of Karnataka which were discarded after silk-reeling. Pupae were cleaned properly and were dried under open sun and solar tunnel dryer until required moisture content was obtained (8 % w.b). The dried pupae were further subjected to biochemical analysis such as crude protein, total fat, ash content, and colour. The quality parameters of dried silkworm pupae were analysed to study the effect of drying silkworm pupae in solar tunnel dryer in comparison with the open sun yard drying.

Chemical analysis

Estimation of crude protein using nitrogen determined by Kjeldahl method

From knowledge of the nitrogen content of biological materials, an estimate can be made of the crude protein content of the sample. It is known that most proteins contain 16 percent nitrogen on an average. Thus percent nitrogen multiplied by factor 6.25 will give the crude protein content of the sample. Weigh 0.5 g the sample and transfer to a dry Kjeldhal flask. Add 8 to 10g of digestion mixture followed by 2.5 ml of Conc. H_2SO_4. Digest the contents on a low heat for an half an hour to avoid frothing. Later continue digestion on a high heat for another 1.5 to 2 hrs till the contents in the flask turn colourless or light blue. Then transfer the contents of the kjeldhal flask to distillation apparatus, distil ammonia and collect in 2 % boric acid and estimate the N_2 content by titrating the collected NH_3 against standard acid.

$$\text{N in sample} = \frac{14 \times (\text{Titrate value} - \text{Blank titrate value}) \times 0.1}{\text{W} \times 1000} \times 100$$

$$\text{\% Crude protein in sample} = \text{Per cent nitrogen x } 6.25 \quad (1)$$

Where, 'W' is weight of sample

Estimation of crude fat using petroleum ether by Soxhlet apparatus method

Crude fat content is determined by extracting the fat from the sample using a solvent, then determining the weight of the fat recovered. The sample is contained in a porous thimble that allows the solvent to completely cover the sample. The thimble is contained in an extraction apparatus that enables the solvent to be recycled over and over again. This extends the contact time between the solvent and the sample and allows it time to dissolve all of the

fat contained in the sample. In order for the solvent to thoroughly penetrate the sample it is necessary for the sample to be as finely comminute as possible.

Moisture free sample was weighed in moisture free thimbles and crude fat was extracted by refluxing in soxhlet apparatus using petroleum ether as solvent. Per cent crude Fat was calculated by difference[1].

$$\text{Crude fat } \% = \frac{\text{Initial weight (g)} - \text{Weight after extraction (g)}}{\text{wieght of sample (g)}} \times 100 \qquad (2)$$

Estimation of Total Mineral Matter (ASH)

Total mineral matter (ash) was determined by igniting samples in muffle furnace at 600°c for 3 - 4 hours[1]. The total mineral matter was expressed as per cent.

$$\text{Total mineral content } \% = \frac{\text{Weight of crucible ash (g)}}{\text{Weight of crucible with sample (g)}} \times 100 \qquad (3)$$

Colour measurement by using Minolta chroma meter

The colour of silkworm pupae was determined by using Minolta chroma meter CR-200b. Minolta chroma meter converts all colours within the range of human perception into a common numerical code with L^*, a^*, b^* colour notations where 'L^*' indicates 'value' giving lightness or darkness of colour, 'a^*' indicating 'Hue' giving which colour (VIBGYOR) and 'b^* indicating 'Chroma' giving the vividness or dullness in colour indicating saturation of colour. The procedure had 10 replications. The colour of pupae before and after drying was determined to understand the changes in colour due to drying.

Statistical analysis

All the experiments in the study were conducted in triplicate and mean values reported. Factorial randomised complete block design (RCBD) was used to analyse the data. After proper analysis, data were accommodated in the tables as per the needs of objectives for interpretation of results. To analyse the data OPSTAT and WASP (Web Agri stat package) Statistical Software Package for Agricultural Research were used. Analyses of variance (ANOVA) were conducted to determine whether significant effect exists on partial sun dryings on the quality parameters of solar tunnel dried silkworm pupae. The below table shows treatment details followed to conduct experiment under solar tunnel dryer.

Treatment details

Multivoltine breed (PM ×CSR_2)	**Bivoltine breed (CSR_2×CSR_4)**
$\mathbf{T_1}$: Multivoltine breed × 10 kg × 60 % MC	$\mathbf{T_5}$: Bivoltine breed × 10 kg × 60 % MC
$\mathbf{T_2}$: Multivoltine breed × 15 kg × 60 % MC	$\mathbf{T_6}$: Bivoltine breed × 15 kg × 60 % MC
$\mathbf{T_3}$: Multivoltine breed × 10 kg × 50 % MC	$\mathbf{T_7}$: Bivoltine breed × 10 kg × 50 % MC
$\mathbf{T_4}$: Multivoltine breed × 15 kg × 50 % MC	$\mathbf{T_8}$: Bivoltine breed × 15 kg × 50 % MC

RESULTS AND DISCUSSION

Treatment	Protien	Fat	Ash	Color values		
				L*	a*	b*
T1	46.32	29.46	5.28	43.13	4.66	7.57
T2	48.23	30.30	4.03	43.95	5.24	8.47
T3	40.27	29.59	3.63	41.55	4.46	6.33
T4	39.66	26.64	4.46	42.45	4.80	7.29
T5	49.44	29.06	4.50	44.43	5.19	9.47
T6	46.48	29.93	4.16	46.20	5.32	10.33
T7	49.17	26.21	4.25	45.28	4.93	9.37
T8	45.36	27.57	4.37	45.05	4.62	8.94
Sun dried	41.45	27.17	3.76	42.94	3.83	8.86
Control	52.60	31.20	5.30	48.30	8.63	14.66
F-test	*	*	*	*	*	*
Sem ±	0.90	0.51	0.20	0.23	0.11	0.15
CD at 5 %	2.71	1.52	0.60	0.71	0.33	0.46

* Significant

Protein content

The protien content of fresh silkworm pupae was found to be 52.6 %. The data obtained was analysed statistically and it was found to be significant at 5% level is depicted in (Fig.2). It was observed that open sun dried silkworm pupae has lower protein content value of (41.45%) compared to solar tunnel dried silkworm pupae. In case of solar tunnel dryer the data indicated that the treatment T_5 had highest protein content value of (49.44%) compared to with other treatment this is due to partial sun drying and thickness of bed were less in this treatment. The treatment T_4 had lower protein content value of (39.663%) this is due to more exposure of sun light and bed thickness compared to other treatments. The results are closer to the value of Tomotake *et al.*[8] investigated crude protein percentage in defatted pupae in CSR_2 X CSR_4 and PM X CSR_2 were 55.61 and 55.72 respectively whereas crude protein percentage were less in undefatted pupae CSR_2 X CSR_4 (49.12%) and PM X CSR_2 (41.01%). A dry pupae contains 45-49% of protein[3].

Fat content

The fat content of fresh silkworm pupae was found to be 29.02 %. The data obtained was analysed statistically and it was found to be significant at 5% level is depicted in (Fig.2). It was observed that open sun dried silkworm pupae has lower fat content value of (27.17%) compared to solar tunnel dried silkworm pupae. In case of solar tunnel dryer the data indicated that the treatment T_2 had highest protein content value of (30.303%). The treatment T_7 had lower protein content value of (26.213%). The similar results were reported by Winitchai *et al.*[9], extracted oil from five native Thai silkworm varieties, Keaw Sakon, Nangnoi Srisaket,Sam Rong, Nang Luang and None Ruesee. The yields of the oils by the Soxhlet and maceration methods were in the ranges from 24–29%.

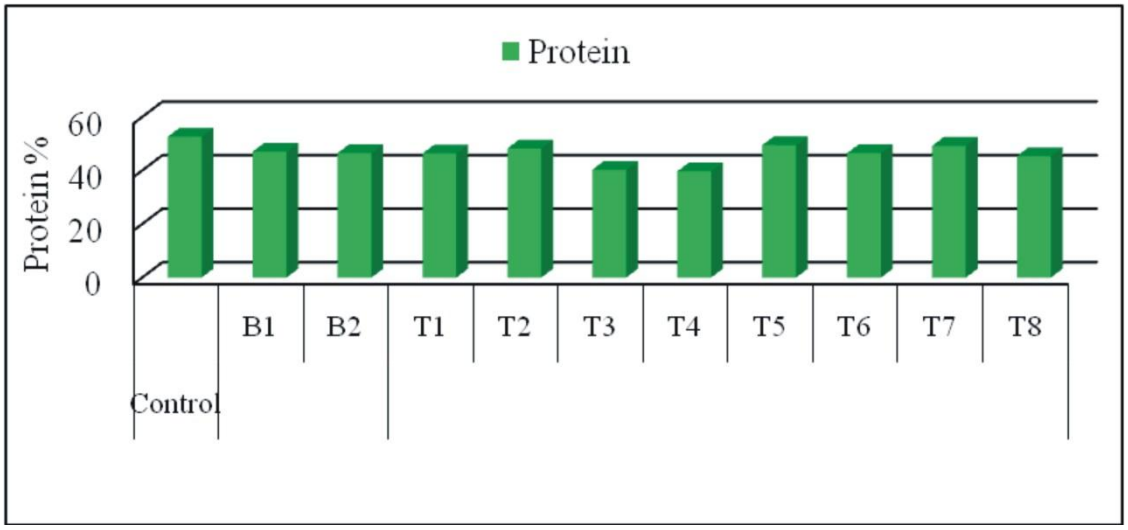
Ash content

The ash content of fresh silkworm pupae was found to be 5.30 %. The data obtained was analysed statistically and it was found to be significant at 5% level is depicted in (Fig.3). It was observed that open sun dried silkworm pupae has lower ash content value of (3.76 %) compared to solar tunnel dried silkworm pupae. In case of solar tunnel dryer the data indicated that the treatment T_1 had highest ash content value of (5.28 %). The treatment T_7 had lower ash content value of (3.63%). The similar results were reported by Mishra *et al*[5]. Ash content of defatted pupae were 7.3% and 6.97% (CSR_2 X CSR_4 and PM X CSR_2).

Color values

The colour L*, a*, and b* value of fresh silkworm pupae was found to be 48.3, 8.63

and 14.66. The data obtained was analysed statistically and effect was found to be significant at 5 % level (Table.1). It was revealed from the results that, the solar tunnel dried pupae of treatment T_6 showed superiority in recording highest L* value of 46.2 and the lowest L* value of 41.55 was found in treatment T_3. It was observed from the results that, the solar tunnel dried pupae of treatment T_6 showed superiority in recording highest a* value of 5.323 and the lowest a* value of 4.46 was found in treatment T_3. From results sun dried silkworm pupae has lower a* value of (3.83) compared to solar tunnel dried silkworm pupae. The results showed that, the solar tunnel dried pupae of treatment T_6 showed superiority in recording highest b* value of 10.33 and the lowest b* value of 6.33 was found in treatment T_3. Colour is physiological property of food products, which affects the enjoyment of eating. This difference in values was mainly due to the effect of temperature on heat sensitive compounds such as protein and vitamins which cause color degradation in fresh food.



Note: B_1- multivoltine breed, B_2- bivoltine breed

Fig. 1: Effect of drying on total protein content of silkworm pupae

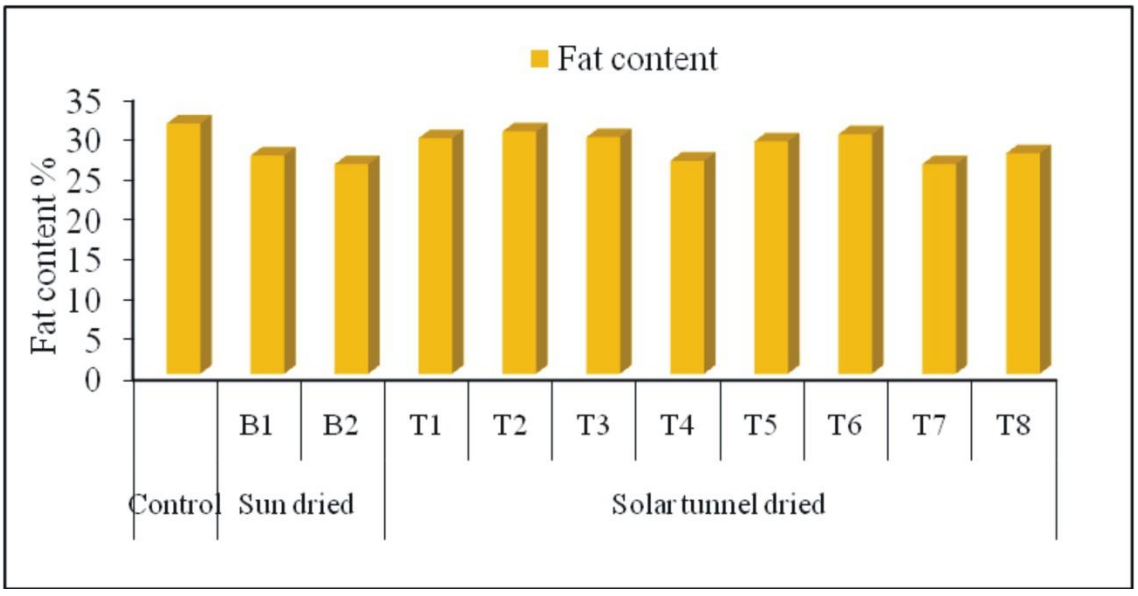


Fig. 2: Effect of drying on total fat content of silkworm pupae

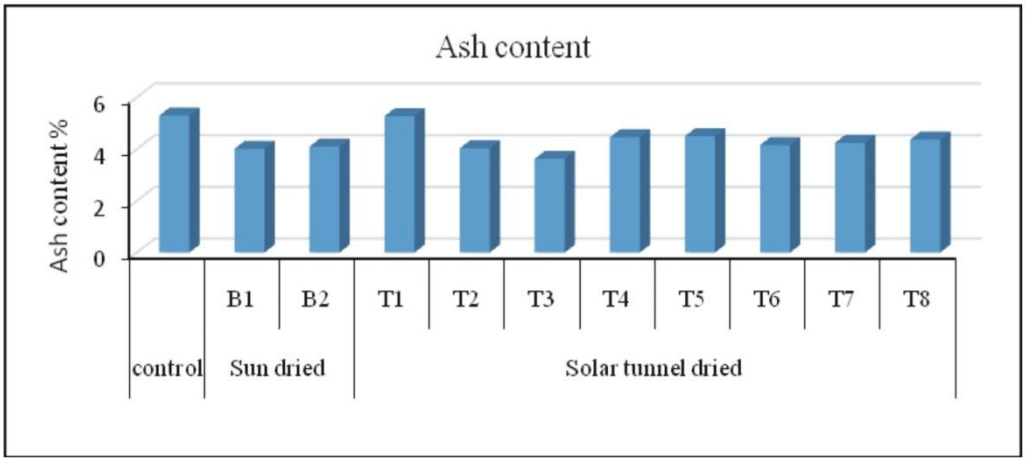


Fig. 3: Effect of drying on total ash content of silkworm pupae

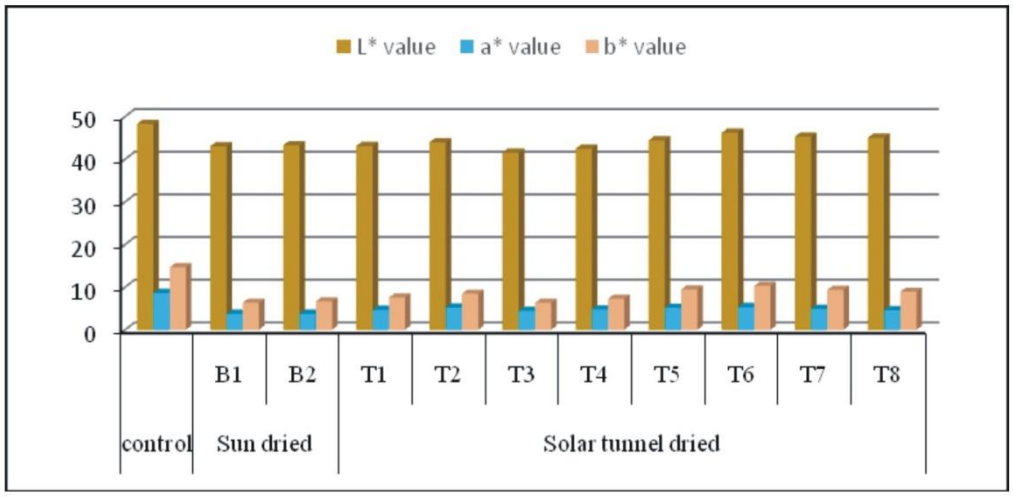


Fig. 4: Effect of drying on color values of silkworm pupae

CONCLUSION

The results suggested that both the hybrids of PM X CSR_2 and CSR_2 X CSR_4 were good sources of protein, fat and ash content. Because of high content of protein, the waste pupae are generally used for formulating poultry, cattle, pig and fish diets etc. silkworm pupae is a new interesting creature for silk production and is developed as a sustainable high protein food source. It is a safe food with diverse cooking preparations and is ideal as high-protein food for school children, rural dwellers and local communities.

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