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Research Article

Biochemical Analysis of Different Millet Varieties (Finger Millet, Pearl Millet, Barnyard Millet & Sorghum) and Study the Feeding Preference of *Tribolium castaneum*

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ABSTRACT

In this study, experiment was conducted in DPPSH Laboratory, at IIFPT, Thanjavur (Tamil Nadu) 2018-19. Under laboratory conditions, four millet varieties viz., Finger millet (Eleusine coracana), Barnyard Millet (Echinochloa esculenta), Pearl millet (Pennisetum glaucum) and Sorghum were tested against Tribolium castaneum to evaluate the feeding preference and larva development time of T. castaneum. As for as development time was concerned maximum development time was observed in Finger millet (Eleusine coracana). Development time of T. castaneum in different millet varieties was Finger millet (17.01 days), Sorghum (12.33 days), Barnyard millet (6.33 days) and Pearl millet (5.56 days). According to this study we can develop the protocols for the safe storage of millets. The study infers that among the millets, T. castaneum prefers pearl millet for its accelerated development.

Key words: *Feed preference; Biochemical Analysis; Development Time; Millet.*

INTRODUCTION

Food safety is the major reported concern to the world's population, which mainly revolves around the sustainable utilization of food grains. Millets are historical food crops, profoundly known as the reservoirs of nutrition for a higher fitness[9]. Millets (likes sorghum, pearl millet and small millets) are critical meals and fodder vegetation in semi-arid areas of Asia and some other international locations. They are taken into consideration to be nutritionally sound as their kernels contain excessive quantity of proteins, minerals, flavonoids, polyphenols, and nutrients also[11]. These mainly comprise of some short grown grasses, extensively known round the world as low water requirement cereals, are coarse with plenty of vitamins. These crops are attuned to an extensive range of temperatures, moisture-regimes and input conditions imparting earnings to thousands and thousands of dryland farmers, in particular within the growing and third global countries.

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The most essential species can be phrased as pearl millet or bajra, finger millet or ragi, proso millet or chena, foxtail millet or kangni debts for nearly 1/2 of global millet manufacturing within the world. The other species, apart from the aforementioned, are regionally vital meals grains specially constrained to small areas or individual nations. Millet fortification and introduction of high iron pearl millet in India to cater iron deficiency was a great move by the researchers. As they are a potent source of crucial and essential amino acids, and other biomolecules required for the development of the body in addition to antioxidants and fiber, those grains could be crucial functional ingredients of the daily diet for prevention of noncommunicable and sicknesses in children as well as adults . Millet's excessive protein content makes up for energy deficiency in vegetarian food regimen. Millets are the excellent ingredients for the existing and for the destiny, their short growing season - from planted seeds to mature, ready to reap vegetation in as little as 65 days – cause them to commercially annoying. When well saved, complete millets will keep for 2 or greater years. Several health promoting residences of millets include, antioxidant property having ability health advantages, gluten loose, useful for humans with celiac disorder who are gluten intolerant, useful for human beings stricken by atherosclerosis, diabetic coronary heart ailment[7]. Most world populace depends upon cereals as their staple food. Wheat, rice and corn had been the favoured cereals, while millets have largely been not noted, greater so in the aftermath of inexperienced revolution. Distinctive attributes of the millets are their version to detrimental climatic conditions, requirement of minimal inputs, and advanced dietary properties. For the preference test we choose the *Tribolium castaneum* insect. Both the adults and larvae of *Tribolium castaneum* damage the host, which loses its structure and is converted into fine powder or frass. They are the reason for the extensive damage to grains during the storage and handling which results in qualitative and quantitative loss of millets. It is found ubiquitous, which makes it perfect for the storage study of millets.

MATERIAL AND METHODS

1.1. Sample

Representative grain samples of four small millet varieties were collected from Valwill Sudesi Farmers Producer Company Limited, Namakkal (South region), Tamil Nadu, India, is used in the experimental analysis.

1.2. Biochemical analysis of millets

- Total nitrogen content was determined by the standard Kjeldahl method followed by digestion, distillation than titration procedure then protein percent is calculated by standard AOAC official methods[2].
- Fat content of millet was determined by the standard soxhlet extraction; grounded sample (millet) of 5-10g of test portion in thimble were dibbed and heated for 2 hours in soxhlet apparatus using petroleum ether (30-60°C) by standard AOAC procedure then dry the beaker in hot air oven for several hours till all the moisture should remove approximately 1-2 hours at 100-110°C then fat percent is calculated.
- Fiber content of millet is determined by the standard AOAC methods; 2g grounded test portion millet sample is extracted with n-hexane. Then extract was boiled in 1.25% sulphuric acid for a time period of 30 minutes and was then filtered and again boil in 1.25% Sodium Hydroxide for 30 minutes. Dry the sample in hot air oven for 1-2 hours at 100-110°C then calculated the fiber content of millet.
- Ash content of millet determined by the standard AOAC methods, 5g of millet sample weighed in silica crucible and was kept in muffle furnace at 550°C until the constant weight was achieved, then cooled in desiccator and calculated the ash content of millet.
- Moisture content of millet is determined by standard hot air oven method, 10g of ground millet sample is weighed in weighing dish and placed in hot air oven for 3 hours at standard temperature of 101-110°C.

1.3. Feeding preference test

1.3.1. Olfactometer system

A four arm olfactometer system (designed and developed by Moscout enterprises, Coimbatore, Tamil Nadu) enclosed in 60.96cm × 45.72cm × 20.32cm metal cabinet was used. Holes in the rear portion allowed for the connection via Teflon and glass tubes to the treatment chamber for the olfactory sample vessel.

1.3.2. The olfactory sensing vessel

The horizontally placed olfactory sensing vessel were designed to hold test samples (in small quantity) with the far and for the Teflon pipe collection and the rear connected to the treatment chamber with a male glass joint that passes the air from odour source (the test sample) for the diffusion of volatiles to happen[10].

1.3.3. Olfactory analysis: Free choice host preference test

Olfactory sense is the major turnout to look for preference and measures sense of insects to sense and determine the position of different resources for their needs[5]. Millets were used in the study as the olfactory source in order to obtain the likeliness of the insect towards a particular host kernels. This can also be turned a free choice host preference test. The odour source vessels were fill with 10g of odour source (millets as a host) on each arm and count of 50 healthy uniform aged adults of *Tribolium castaneum* were introduced in the treatment chamber. The cycle of analysis started with initial vacuum sun of 10-15 minutes, makes the treatment chamber completely odour free followed by the onset of the air supply introduced the respective volatile to the chamber. The whole scenario was observed until a complete distribution takes place form the treatment chamber. The preference of adult will make them to move towards the likeliest odour and which can easily be investigated via number of insects in the individual odour source vessel.

1.3.4. Real-time method of host preference

Apart from olfactory test, cage study done in order to mimic the real time preference of healthy adults *Tribolium castaneum*. A stainless steel cage of 45.72cm × 33.02cm × 30.48cm dimension with walls made of sieves were introduced with host odour source millets in four different petri dishes and after releasing 50 adults insects of *Tribolium castaneum*, was closed and observed for 24 hours. The preference will take the insects to particular petri dish with a definite sample, which can be assessed by the number of insects in it.

1.4. Insect development study

10 number of larva stage of *Tribolium castaneum* (3rd instar), which was earlier cultivated using wheat flour were added to 20g of millets individually in separate observation culture box 150g capacity at 28 ± 0.5°C and considerable relative humidity (RH)[4]. It was regularly monitored under lab conditions to be converted into healthy adults, which can further mate and lay eggs for further generations. The development time of insects in individual culture boxes were determined at 24 hours intervals in triplicates, which were later taken for weight loss in sample to infest the feeding pattern of the insect in the particular millet sample.

RESULT AND DISCUSSION

The chemical composition of a stored grain will majorly affect the attraction of an insect for the oviposition / preference towards the particular host. Table 1 clearly demonstrate the biochemical outlook of the millet study.

Table 1: Biochemical analysis of millets

Variety of millet	Moisture (%)	Crude Protein (%)	Fat (%)	Crude Fibre (%)	Ash (%)	Carbohydrate (%)
Finger millet	7.11±0.23	11.65±0.22	0.58±0.04	3.48±0.18	2.24±0.15	72.62±0.80
Barnyard Millet	8.74±0.14	10.76±0.22	2.46±0.20	10.73±0.54	4.56±0.21	65.92±0.60
Pearl millet	7.87±0.29	11.43±0.41	3.51±0.36	2.63±0.15	2.71±0.27	67.50±1.15
Sorghum	8.56±0.33	9.73±0.31	3.03±0.20	2.11±0.18	1.98±0.43	70.85±0.39

All the data are significant at 5%

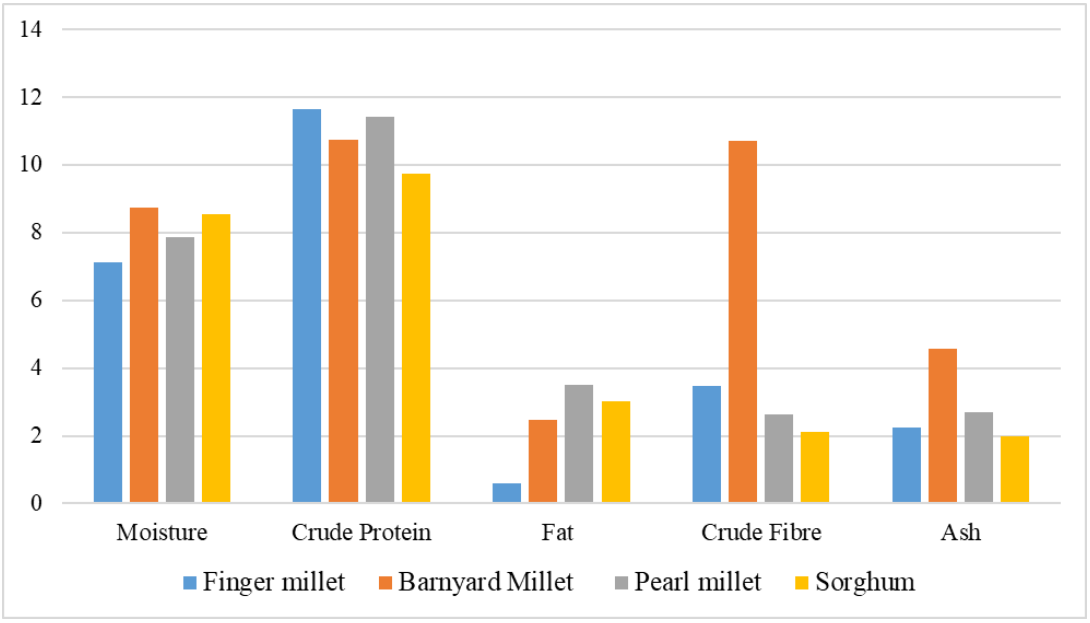

Fig. 1: Proximate composition of millets

The analysis depicts finger millet to be highest in proteins, followed by pearl and barnyard millet. The same trend is shown in the carbohydrate content of the millets also, with finger millets having 72.16% carbs, sorghum with 70.33, pear millet having 67.93% and barnyard millet having 65.60% carbohydrate content. But, in the case of fibre content of these four, barnyard came out to be the highest, having 10.73% of crude fibre content, rest all in the range of 3.48 to 2.11 %.

Preference of *Tribolium castaneum* adults during olfactometer is presented in Table 2. The insects preferred Sorghum after the olfactory trials and Barnyard millet was determined as the least preferred one. The same trend was observed in the real-time cage study, where sorghum again come out to be the one with most insects being attracted towards. This can be clearly summarised from the result in Table 3.

Table 2: Olfactory analysis of *Tribolium castaneum* on various millet samples

Olfactory Source	Insect Attracted (Mean ± SD)	Insect's Attraction Average (%)
Sorghum	17 ± 1.51	34.00
Finger millet (*Eleusine coracana*)	14 ± 1.23	28.00
Pearl millet (*Pennisetum glaucum*)	9 ± 1.42	18.00
Barnyard Millet (*Echinochloa esculenta*)	6 ± 1.64	12.00
Confused insect	4 ± 1.32	8.00

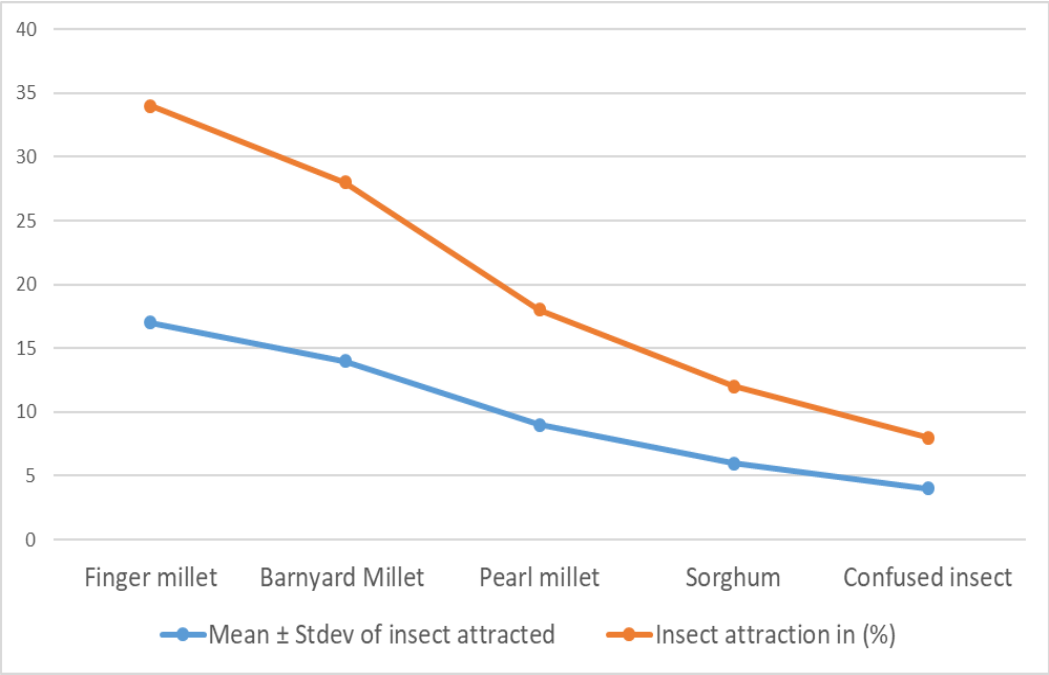

Fig. 2: Insect attraction towards different millet samples using olfactory system

Table 3: Cage analysis of free choice host preference

Olfactory Source	Insects Attracted (Mean ± SD)	Insect's Attraction Average (%)
Sorghum	16 ± 1.63	32.00
Finger millet (*Eleusine coracana*)	13 ± 1.21	26.00
Pearl millet (*Pennisetum glaucum*)	9 ± 1.45	18.00
Barnyard Millet (*Echinochloa esculenta*)	5 ± 1.73	10.00
Confused insect	7 ± 1.75	14.00

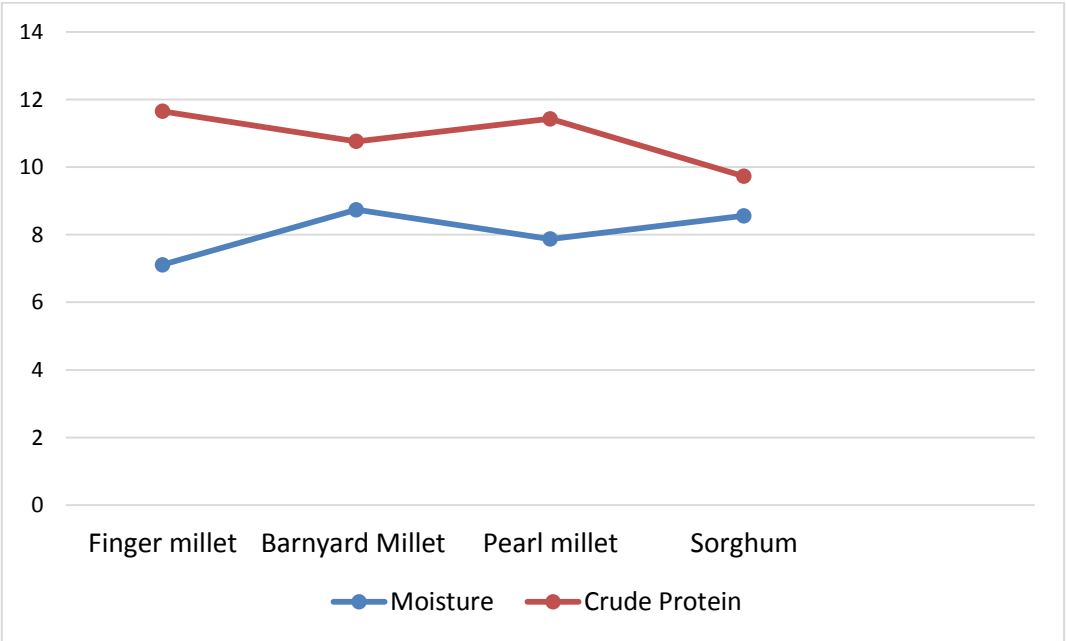

Fig. 3: Insect attraction towards different millet samples (real-time analysis)

Table 4: Weight loss of millets and development time of *T. castaneum*

Parameters	Sorghum (g)	Finger millet (g)	Pearl millet (g)	Barnyard Millet (g)
Initial weight	10.00	10.00	10.00	10.00
Final weight (Average)	9.51	9.92	9.82	9.39
Weight loss (after15 days)	0.49	0.08	0.18	0.61
Development time (days)	12.33	17.01	5.56	6.33

The results clearly indicate a variation in the oviposition or hiding in different millet samples. As *Tribolium castaneum* is an external feeder, so it would be have been simple for it to target the small sized Sorghum as compared to others, which obviously are much hard than the sorghum. This is why Sorghum is much prone to get infested and quality deterioration is much during the storage due to the insect attracts. At the end some insects are found in the treatment chamber itself which can be considered as the confused due to the olfactory conditions, which they can't sense.

CONCLUSION

Storage insect preferences depends on the homeostasis condition of the particular environment. Oviposition or hiding and feeding by insect shows its attraction towards a particular host. Here the nutritional composition takes much of the part for insect to develop without any noted issues. Data for preference studies of major cereal grains such as wheat, rice and maize is much into picture, but studies on millets are still in infancy, so accessing the insect behaviour and its affection to the nutritional composition from the present study will further help in making protocols for safe storage of the millets.

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