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### RESEARCH ARTICLE

## GENETIC VARIABILITY CHARACTERIZATION OF SOME *EX SITU* CONSERVED FINGER MILLET (*ELEUSINE CORACANA* (L.) GAERTN. SUBSP. *CORACANA*) GERMPLASM ACCESSIONS IN SRI LANKA USING QUALITATIVE MORPHOLOGICAL MARKERS.

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#### Abstract

Finger millet (*Eleusinecoracana*) [order Poales, family Poaceae, sub family Chloridoideae] ranks fourth in importance among millets in the world. This crop is grown in the arid and semiarid regions of the world. *E. coracana* has a greater nutritional value. This study was performed on 42 germplasm accessions of finger millet conserved at the Plant Genetic Resource Center (PGRC), Gannoruwa, Sri Lanka. These germplasm accessions comprised of 27 Sri Lankan accessions, 11 Indian accessions, 2 Zimbabwean accessions and 2 recommended varieties of Sri Lanka. Qualitative traits taken into consideration were Pigmentation, Growth habit, Ear shape, Ear size, Finger branching, Discontinuity of spikelet, Lodging susceptibility, Spikelet shattering, Grains covering by glumes, Grain colour, Grain shape and Grain surface. Out of them, Pigmentation and Finger branching were monomorphic for the studied accessions while rest of ten traits were polymorphic. Characters were scored following International Plant Genetic Resource Institute (IPGRI) descriptors developed for finger millet. The majority of individual plants was found to possess erect stem (71.4%), semi-compact shaped ears (68.1%), small size ears (41.5%), no discontinuity of spikelet on finger (92.0%), no lodging susceptibility at maturity (61.8%), no spikelet shattering at maturity (95.1%), enclosed grains covering by glumes (71.5%), light brown colour grains (34.9%), round shaped grains (96.9%) and smooth grain surface (95.0%). Important objective of any plant scientist is to identify an optimum number of plant traits which are sufficient to explain the maximum variability in the crop growth from sowing to harvest. Results of the study suggest a considerable morphological variability, which could exist among the studied accessions. This finding justifies the importance of germplasm characterization.

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#### Introduction:-

Finger millet (*Eleusinecoracana*) [order Poales, family Poaceae, sub family Chloridoideae] ranks fourth in importance among millets in the world after sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum glaucum*) and foxtail millet (*Setaria italica*). This crop is grown in the arid and semiarid regions of the world. Historical records

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suggest that the origin of *E. coracana* probably happened about 5000 years ago at somewhere in the region that is currently known as Uganda. It has been cultivated in India since 3000 years ago (Sirinivasachary *et al.*, 2007). Finger millet grain can be stored for years without storage pests, which makes it a perfect food grain commodity for famine prone areas (National Research Council 1996).

*E. coracana* has a greater nutritional value. Both grain and hull of finger millet have considerable nutrient content. The grain contains carbohydrate, protein, fat, fibers, iron, calcium, minerals and essential amino acids such as leucine, tryptophan, phenylalanine and methionine. The hull contains protein, fiber, Calcium and phosphorus. Consequently, this can be considered as the major preventive agent against malnutrition. Content of each component can be changed according to the crop variety. However each and every variety has its own nutritive value. *E. coracana* is used as a traditional medicine for several diseases such as liver disease. Villagers make plait bracelets using leaves and clumps of this crop. Chemicals such as hydrocyanic acid are obtained from finger millet. Since finger millet grains are much harder it is less susceptible to diseases and pests. But Finger millet blast disease is one of threats for the farmers who cultivate finger millet (Ulaganathan and Nirmalakumari, 2015).

There are several important attributes of finger millet including adaptability to adverse agro-ecological conditions with minimal inputs, tolerant to moisture stress, can be produced on marginal land where other crops cannot perform, and tolerant to acidic soil (Barbeau and Hilu, 1993).

The genetic diversity study of a crop species is essential in many aspects including effective utilization of germplasm in plant breeding programs, identification of appropriate sampling procedures for germplasm collection and conservation, obtaining some collections for efficient germplasm management and explicating the taxonomy, evolution and origin of crop species (Assefa *et al.*, 2002; Bekele, 1985; Demissie and Bjonstrand, 1996). Therefore, important objective of any plant scientist is to identify an optimum number of plant traits which are sufficient to explain the maximum variability in the crop growth from sowing to harvest (Ulaganathan and Nirmalakumari, 2015). The present study was conducted to assess phenotypic diversity of randomly selected 42 finger millet germplasm accessions conserved at PGRC, Gannoruwa, Sri Lanka.

Major aim of this article is to reveal the few of qualitative morphological characteristics of the studied finger millet germplasm accessions. There are more studies that revealing the genetic diversity of finger millet germplasm accessions conserved in Sri Lanka using quantitative morphological markers and SSR markers (Dasanayaka (2016); Kaluthanthri and Dasanayaka, (2016); Wakista *et al.*, (2016)).

### Materials and Methods:-

This study was performed on 42 germplasm accessions of finger millet conserved at the Plant Genetic Resource center (PGRC), Gannoruwa, Sri Lanka (Table 01). These 42 germplasm accessions comprised of 27 Sri Lankan accessions, 11 Indian accessions, 2 Zimbabwean accessions and 2 recommended varieties of Sri Lanka.

Seeds of each accession were sown in small plastic pots filled with normal soil, and keep the spacing between the seeds. Pots were irrigated soon after sowing and placed in a plant house. Two weeks old seedlings were transplanted separately in the large plastic pots filled with mixture of soil, sand and compost (1:1:1) as each pot contained 4 plants. Data were recorded on twelve qualitative parameters. Qualitative traits taken into consideration were Pigmentation, Growth habit, Ear shape, Ear size, Finger branching, Discontinuity of spikelet, Lodging susceptibility, Spikelet shattering, Grains covering by glumes, Grain colour, Grain shape and Grain surface. Characters were scored following International Plant Genetic Resource Institute (IPGRI) descriptors developed for finger millet.

### Data Analysis:-

Frequency distribution of ten polymorphic qualitative traits and its graphical representation were obtained using software IBM SPSS Statistics version 21 and Microsoft office excel 2007.

**Table 01:-**Details of the 42 finger millet germplasm accessions used for the study.

Accession No.	Accession Name	Origin of Accession	Organization
122	KobeyKurakkan	Moneragala	PGRC

190	Gal Bora	Hambanthota	PGRC
192	EDAL – KUR	Hambanthota	PGRC
258	Kurakkan	Hambanthota	PGRC
418	GAL Kurakkan	Kurunegala	PGRC
426	EDAL Kurakkan	Kurunegala	PGRC
909	INDAE/9	India	Unknown
910	HR 374	India	Unknown
911	SEL No - 4	India	Unknown
923	RAG15-6	India	Unknown
925	PR 202	India	Unknown
926	GPU 114	India	Unknown
927	PES 110	India	Unknown
928	GPU 5	India	Unknown
959	Kurakkan	NuwaraEliya	PGRC
960	Kurakkan	NuwaraEliya	PGRC
962	JNR – 3B – 1008	India	RARS/AK
963	CO-10	India	RARS/AK
964	KM – 1	India	RARS/AK
967	Line 40	Hambantota	PGRC
1201	Kurakkan	Anuradhapura	PGRC
1233	Kalu Gal Kurakkan	Matale	PGRC
1304	KiriMoraKurakkan	Rathnapura	PGRC
1331	BalaKurakkan	Rathnapura	PGRC
1815	BalaKurakkan	Kandy	PGRC
1828	Kalu Gal Kurakkan	Kandy	PGRC
3011	Kurakkan	Hambanthota	PGRC
3021	Maha Mora Kurakkan	Hambantota	PGRC
4989	Kurakkan	Puttalam	PGRC
6580	Kurakkan	Moneragala	PGRC
6586	Kurakkan	Matale	PGRC
7089	Kurakkan	Kurunegala	PGRC
7109	SDFM 1143	Zimbabwe	ICRISAT
7123	SDFM 2564	Zimbabwe	ICRISAT
7769	Kurahan	Polonnaruwa	PGRC
7777	Kurakkan	Badulla	PGRC
8389	HaramusKurakkan	Anuradhapura	PGRC
8470	Makala Kurakkan	Moneragala	PGRC
8796	Kurakkan	Kegalle	PGRC
9083	KahaKurakkan	NuwaraEliya	PGRC
9294	Ravi	Recomended variety	PGRC
10326	Ravana	Recomended variety	PGRC

### Results:-

Out of 12 recorded qualitative morphological traits, only two traits namely pigmentation and Finger branching did not show any range of variability across the studied 42germplasm accessions. In other words, none of individual

plant showed any kind of pigmentation or finger branching. The frequency distribution of ten polymorphic qualitative traits is given in Table 02 and its graphical representation is shown in Figure 01.

In this study, three morphological states of growth habit (erect, prostrate and decumbent) were observed. Results showed that majority of plants (71.4%) were erect, 120 plants (24.0%) were Prostrate and the remaining 23 plants (4.6%) were decumbent.

Four morphological states of ear shape were observed. Majority of plants was found to possess (68.0%) semi-compact shape whereas 95 plants (19.0%), 52 plants (10.4%) and 13 plants (2.6%) were found to possess Compact, Open and Fist like shapes respectively.

In case of ear size, small size ears were found in 208 plants (41.6%), intermediate size ears were found in 156 plants (31.2%) and only 136 plants (27.2%) were found to possess large size ears. Among 500 individual plants, only 40 plants (8.0%) were found to possess discontinuity of spikelet on finger of their ears.

Based on lodging susceptibility at maturity, it was observed that among studied plants, 309 plants (61.8%) were not lodged at all while rest of plants was lodged. In here, 93 plants (18.6%) showed low lodging, 49 plants (9.8%), showed intermediate lodging and rest of 49 plants (9.8%) showed high lodging.

Regarding Spikelet shattering at maturity, majority of plants (95.0%) were not found to possess ears which shattered their spikelet at maturity.

Three types of glumes were observed in this study. Most of grains (71.6%) were completely covered by glumes (Enclosed) and 17.4% of grains was partially covered by glumes (Intermediate). Remaining 11.0% of grains was not covered by glumes.

Four types of grain colour were observed in finger millet those used in this study. Among the studied plants, 175 plants (35.0%) had light brown colour grains, 150 plants (30.0%) had Dark brown grains, 135 plants (27.0%) had Copper brown colour grains and remaining 40 plants (8.0%) had White colour grains.

Only two grain shapes were observed in this study. Majority of plants (97.0%) had round shaped grains whereas remaining plants (3.0%) had reni form shaped grains.

In the case of grain surface, majority of plants (95.0%) had smooth grains while remaining plants had grains with wrinkled surface.

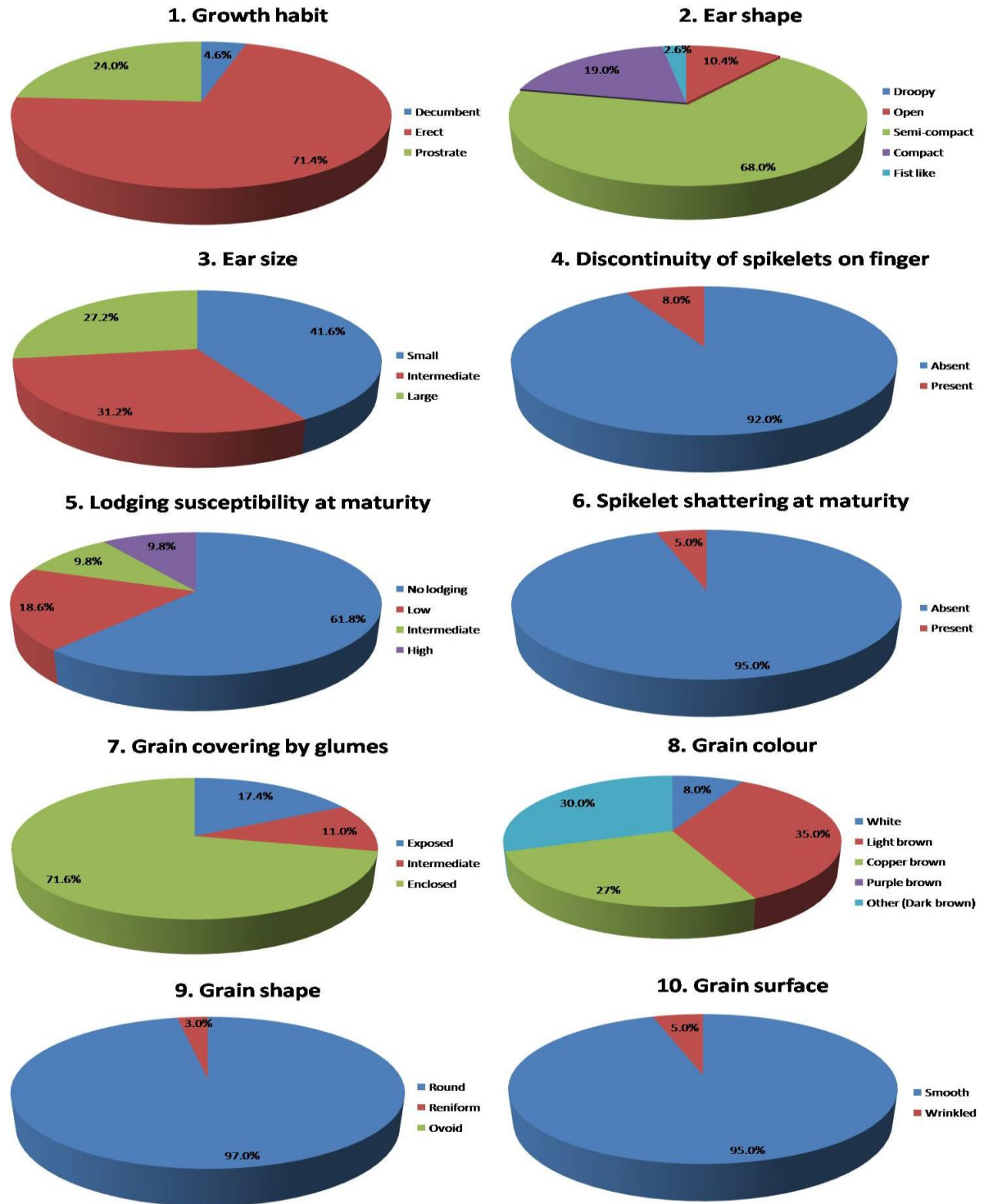


Figure 1:- Graphical representation for frequency distribution of ten polymorphic qualitative traits of finger millet

**Table 2:-**Frequency distribution of ten polymorphic qualitative traits in finger millet germplasm accessions

Morphological character	Character type	Frequency	Valid Percent (%)
1. Growth habit	Decumbent	23	4.6
	Erect	357	71.4
	Prostrate	120	24.0
2. Ear shape	Droopy	0	0
	Open	52	10.4
	Semi-compact	340	68.0
	Compact	95	19.0
	Fist like	13	2.6
3. Ear size	Small	208	41.6
	Intermediate	156	31.2
	Large	136	27.2
4. Discontinuity of spikelet on finger	Absent	460	92.0
	Present	40	8.0
5. Lodging susceptibility at maturity	No lodging	309	61.8
	Low	93	18.6
	Intermediate	49	9.8
	High	49	9.8
6. Spikelet shattering at maturity	Absent	475	95.0
	Present	25	5.0
7. Grain covering by glumes	Exposed	87	17.4
	Intermediate	55	11.0
	Enclosed	358	71.6
8. Grain colour	White	40	8.0
	Light brown	175	35.0
	Copper brown	135	27
	Purple brown	0	0.0
	Other (Dark brown)	150	30.0
9. Grain shape	Round	485	97.0
	Reniform	15	3.0
	Ovoid	0	0.0
10. Grain surface	Smooth	475	95.0
	Wrinkled	25	5.0

**Discussion:-**

In this study, three morphological states of growth habit (erect, prostrate and decumbent), four morphological states of ear shape (open, semi compact, compact and fist like), three morphological states of ear size (small, intermediate and large), four morphological states for lodging susceptibility (no lodging, low lodging, intermediate lodging and high lodging), three morphological states of grains covered by glumes (exposed, intermediate and enclosed), four morphological states of grain color (white, light brown, copper brown and dark brown), two morphological states of grain shape (round and reniform) and two morphological states for grain surface (smooth and wrinkled) were observed in studied finger millet germplasm accessions. Furthermore, discontinuity of spikelet on finger and spikelet shattering at maturity were not observed in majority of germplasm accessions used in this study.

The majority of individual plants was found to possess erect stem (71.4%), semi-compact shaped ears (68.0%), small size ears (41.6%), no discontinuity of spikelet on finger (92.0%), no lodging susceptibility at maturity (61.8%), no spikelet shattering at maturity (95.0%), enclosed grains covering by glumes (71.6%), light brown colour grains (35.0%), round shaped grains (97.0%) and smooth grain surface (95.0%).



According to the plant colour, finger millet germplasm accessions can be classified into two groups as green colour plants and pigmented plants. There were no pigmented plants with respect to any of studied accessions. Therefore, the trait, pigmentation can be considered as a monomorphic character in this study. Similarly, the character, finger branching can be considered as a monomorphic character reason being not observed in any of studied accessions.

Decumbent, erect and prostrate are the three types of growth habit that can be found in finger millet. In this study, erect type was predominant with frequency of 71.4% followed by prostrate type with frequency of 24.0% where as prostrate type was found in only few individuals from several accessions. However as Bezawele *et al.* (2007) reported the variation in growth habit showed that the decumbent type was more predominant in all regions followed by prostrate type with overall frequency of 25% whereas erect type was found to concentrate in one region with a frequency of 34%. Type of growth habit of a plant involves in its capacity to suppress weeds at early growth stage and its capacity to withstand against the moisture stress. Apparently, if the architecture of a plant can reduce the evapo-transpiration by covering the soil at early stage such architecture could enable the plant to perform better. According to Bezawele *et al.* (2007), prostrate type and decumbent type might be highly preferred by most farmers in different regions which could be due to their capacity to suppress weeds at early growth stage and ability to withstand moisture stress.

According to De Wet *et al.* (1984), inflorescence morphology was associated with grain yield and is used by the farmers to distinguish complexes of cultivars. In this study semi-compact type of ear shape was predominant with frequency of 68.0% whereas droopy ear shape was not found in any plant.

In the case of ear size, majority of plants (41.6%) composed of small size ears whereas 31.2% and 27.2% of plants composed of intermediate and large size ears respectively.

In this study 92.0% of plants did not show discontinuity of spikelet on finger.

Lodging can be defined as the permanent displacement of a plant from its vertical position. Lodging of finger millet plants was recorded by looking at the angle of displacement of the stem from the vertical position where 0° is no displacement. In this study, no lodging was predominant with frequency of 61.8% followed by low lodging with frequency of 18.6% whereas intermediate and high lodging plants were found with equal frequency of 9.8%. In finger millet, grain yield can be reduced mainly due to moisture scarcity and lodging susceptibility of the plants. And also lodging can be resulted in shriveled and poor quality seed that sprouts on the panicle before harvest. Plant height and Culm thickness have major effect on the lodging susceptibility of a plant.

Spikelet shattering at maturity was absent in 95.0% of plants in this study. One of the key changes often regarded as the characteristic of domesticated grain crops was a shift from natural seed dispersal through shattering mechanisms to obligate dispersal by people (Zohary, 1969; Harlan *et al.*, 1973; Hillman and Davies, 1990, 1999). Shattering occurs by the abscission at the abscission scars, such as the rachilla to spikelet base attachment. But as a result of the loss of abscission at the abscission scars, a plant retains seeds instead of shedding them when they are mature and they are then usually separated by the addition of human labour (threshing and winnowing). This increases the efficiency of harvest and thus yields.

In this study, Majority of plants (71.6%) composed of enclosed grains covering by glumes. In other words majority of grains had tightly bound seed coats with their edible part. However this character state is kind of a challenge to threshing and milling processes (Tsehaye and Kebebew, 2002).

Four different grain colours including Light brown (35.0 %), Dark brown (30.0%), Copper brown (27.0%) and White (8.0%) were observed in this study. However, purple brown coloured grains were not found in this study. Grain colour can be considered as one of the most important traits reason being its involvement in the determination of the quality of the cultivars. As described by Tsehaye and Kebebew (2002), grain colour has an economic value because it is used in variety identification and commercial classification of different varieties of crops. White and reddish coloured grains have considerably high economic value compared to that of dark coloured grains. But farmers prefer to grow dark coloured grains because of its high yield and hardness with respect to climatic hazards such as poor soil fertility. (Kefyalew and Ensermu, 1989). An apparent association between grain colour and human consumption of finger millet can be observed with in Ethiopia as reported by Zemedu (1988).

In this study, round shaped grains and smooth surface grains were predominant with frequencies of 97.0% and 95.0% respectively. As reported by Bezawele et al. (2007), though their adaptive significance is not known, grains with round shape and smooth surface are preferred by consumers in Ethiopia. In the case of finger millet consumption, threshing and milling processes should be performed beforehand. In here, especially in milling, round shaped and smooth surfaced grains might be more advantageous.

### Conclusion:-

The genetic diversity study of a crop species is essential in many aspects including effective utilization of germplasm in plant breeding programs, identification of appropriate sampling procedures for germplasm collection and conservation, obtaining some collections for efficient germplasm management and explicating the taxonomy, evolution and origin of crop species. In this process, qualitative characters are useful in precise characterization of germplasm. The study of 12 qualitative characters revealed that the considerable morphological variation exist among the studied accessions especially for characters such as growth habit, ear shape, ear size, lodging susceptibility, grain covering by glume and grain colour. Findings of this study provide a clue for germplasm collection and conservations.

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