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Study of heritability and genetic variability among morphological and bio-chemical composition of kororima (*Aframomum corrorima* (*braun*) *jansen*) accessions under Jimma condition, Southwestern Ethiopia

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Abstract
Information on genetic variability of traits is prerequisite for further improvement of any crops. Currently, under Ethiopia korarima improvement project, large numbers of korarima accessions are collected from different major growing regions of Ethiopia by Jimma Agricultural Research Center (JARC). As far as the variability and heritability among characters in these accessions of korarima is concerned nothing has been done. Therefore twenty five korarima (Aframomum corrorima) germplasm accessions were tested using simple lattice design at Jimma Agricultural Research Center. Data were recorded on 21 characters with the objective of estimating the extent of variation between pairs of characters. Analysis of variance revealed that there was significance difference among the genotypes for the characters studied except internodal length, seed weight and dry matter content. High phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) recorded for bearing tiller, leaf area, and ash and crud fiber content. High heritability coupled with high genetic advance as percent mean were estimated for plant height, bearing tiller, number of capsule per plant, diameter of fresh and dry capsule, ash, crud fiber and oleoresin content; moderate heritability values coupled with higher genetic advance were observed for total tiller, length of fresh capsule, weight of dry capsule, length of dry capsule, volatile oil and crud fat content. This indicates that these characters could be improved through selection.

Keywords: genetic variability, heritability, korarima

Introduction
Korarima *(Aframomum corrorima* (Braun) P.C.M. Jansen*)* belongs to the family Zingiberaceae and genus *Aframomum*, and originated in Ethiopia. It is a perennial tropical aromatic herb, often of larg size, bearing flowers either terminally on aerial leaf shoots or from ground level. Korarima grows usually with strong fibrous subterranean scaly rhizomes and with leafy stems reaching 1–2 m high. It is usually self-pollinated. The position of stigma in the flower is below or against the base of the anther. Occasionally cross-pollination by insects is possible due to the presence of large nectaries at the top of the ovaries. In Ethiopia, korarima grows naturally at 1,700–2,000 m asl [1].
Korarima, also called "false cardamom", has been part of daily Ethiopian dishes for preparation of curry powder used for culinary purposes. Earlier it was mainly harvested from wildly grown plants in the forests. The dried pods are sold in almost every Ethiopian market and are quite expensive compared to other spices. The seeds are used to flavour coffee, bread, butter and all kinds of sauces. They are ground and often mixed with other spices [1].
Research has comparatively been less in spices and medicinal plants including native plants of Ethiopia (such as korarima) although these plants are widely used in traditional dishes, and sold at higher prices in the local markets than cereal grains [2]. It is essential to assess the pattern of genetic variability in morphological and chemical composition among and between the germplasm. This study can help in identifying elite germplasm accession with the greatest novelty and thus are most suitable for rescue or incorporation into crop improvement programs Therefore, the objective of this work was to estimate the extent of variation between pairs of characters.

Materials and Methods
Description Study Area
The study was conducted on five years old twenty five korarima germplasm accessions including local check. The experiment was superimposed on those which were planted in a 5x5 simple lattice design with two replication and five accessions per incomplete block. Nine plants per plot were planted in 1.8m*1.8m spacing. All the management practices such as shading, weeding, etc were uniformly applied to all plots as per the recommendation.

Data Collection
Data were collected on twenty-one morphological and biochemical composition of korarima. plant height (cm), number of tiller per plant, number of bearing tiller per plant, intermodal length (cm), number of leaves per stem, leaf area (cm^2), number of capsule per plant and yield per plant. For weight of single capsule(g), length of single capsule(cm) and diameter of single capsule(cm) both at fresh and dry base were measured by taking twenty five capsule from each five randomly selected plant of plots. Essential oil and oleoresin extraction was carried out and dry matter, total ash, crud fiber and crud fat content on percent base were determined.

Data Analysis

Data of quantitative characters were subjected to analysis of variance (ANOVA) using SAS version 9.2 [3] to examine the presence of statistically significant differences among genotypes for these characters. Least Significant Difference (LSD) was employed to identify genotypes that are significantly different from each other and the variability of each quantitative trait was estimated by simple measures such as mean, range, standard deviation, phenotypic and genotypic variances, and coefficients of variation. The phenotypic and genotypic coefficients of variation were computed using the formula suggested by Burton and de Vane [4].

Result and Discussion

Mean squares of 21 characters from analysis of variance (ANOVA) presented in table 1. Significant difference among germplasm accessions ($p<0.05$) were observed for all traits expect for seed weight, internodal length and percent dry matter content of korarima seed. Significant to highly significant difference indicates the presence of adequate variability which can be exploited through selection. Different authors reported significance difference on different characters of cardamom genotypes. From those Korikanthimath *et al* [5] reported significance difference among genotypes for number of capsule per plant, weight of fresh and dry capsule and oleoresin content.

Ankegowda and Krishnamurthy [6] also reported number of tiller, number of leaves and plant height show significant difference on six cardamom germplasm accessions under moisture stress condition. Furthermore Momina *et al* [7] evaluated 36 ginger genotypes at two location and reported that number of plant per plot, fresh rhizome yield, dry rhizome yield, oleoresin, volatile oil and crud fiber content had highly significant variation in both location. They also obtained non-significant variation for characters like number of leaf per plant, leaf length, leaf width, leaf area, plant height, rhizome length and width at Tepi. But these characters show highly significant variation at Bahirdar condition. Islam *et al* [8] reported for nineteen ginger genotypes show significant difference for characters like plant height, tiller per plant, leaf length, leaf breadth, number of leaf per plant, dry matter content and rhizome yield per plant.

Table 1: Analysis of variance (mean squares) for 21 characters studied

SV	REP	Treatments		B/REP	ERROR		R^2%	Efficiency in relative to RCBD%	CV%
		Adj	Unudj		Intra block	RCBD			
DF	1		24	8	16	24			
PH (cm)	383.09	669.76**	677.77	104.63	276.28	219.06	79.29	96.38	8.68
TT	0.5202	5.93**	7.0071	2.87	2.293	2.48	82.42	101.56	19.89
BT	0.39	1.24**	1.6	0.56	0.22	0.33	88.42	125.35	20.93
INL (cm)	0.004	0.52^{NS}	0.48	0.23	0.45	0.38	60.28	83.75	13.35
NLPS	1.095	19.52**	20.99	9.49	7.27	8.01	81.78	102.23	9.32
LA (cm^2)	61.16	2826.66**	3428.7	215.76	919.69	685.05	84.71	74.49	16.95
NCPP	0.08	4.06**	4.03	0.8	1.26	1.1	83.37	88.03	12.43
YPP(g)	244.3	5885.59**	5902.39	1393.1	2014.88	1807.62	82.5	89.71	14.47
SW (g)	8.82	0.035^{NS}	0.039	0.014	0.023	0.02	69.29	86.41	7.03
WFC (g)	0.014	28.46*	24.74	16.12	12.54	13.73	75.81	101.96	14.49
LFC (cm)	0.03	6.065*	7.01	3.64	2.85	3.11	78.16	101.91	20.3
DFC (cm)	3.28	4.23**	4.33	2.08	0.95	1.33	83.48	118.34	9.81
WDC (g)	0.23	9.36*	8.05	6.45	3.32	4.36	77.16	113.2	15.78
LDC (cm)	1.4	1.24*	1.64	0.32	0.59	0.5	81.37	84.5	16.39
DDC (cm)	3.28	4.23**	4.33	2.08	0.95	1.33	83.48	118.34	15.48
DRM (%)	0.61	1.41^{NS}	1.49	0.203	1.41	1.62	62.04	103.91	1.37
CRFI (%)	0.0006	0.0048**	0.005	0.0014	0.0011	0.0011	86.41	101.9	15.79
VOC (v/w)	0.23	0.53**	0.85	0.23	0.19	0.21	87.53	101.01	17.93
OC (w/w)	1.48	1.147**	1.12	0.403	0.365	0.378	83.31	100.32	12.03
ASH (%)	0.021	0.48**	0.81	0.16	0.146	0.149	89.82	100.13	15.36
CRFAT%	0.027	0.051**	0.055	0.037	0.021	0.026	81.32	108.66	5.69

** And * indicates significant difference at 1 and 5% respectively, NS not significant

DF: degree of freedom, PH: plant height, TT:total tiller, BT: bearing tiller, IL: internodal length, NLPS: number of leaf per stem, LA: leaf area, NCPP: number of capsule per plant, YPP: yield per plant, SW: 100seed weight, WFC: weight of fresh capsule, LFC: length of fresh capsule, DFC: diameter of fresh capsule, WDC: weight of dry capsule, LDC: length of dry capsule, DDC: diameter of dry capsule, DRM%: dry matter percentage, CRFI%: crud fiber percentage, VOC: volatile oil content, OC: oleoresin content, %ASH: percent ash content, CRFAT%: crud fat percentage

Variance components and coefficients of variation estimate of characters considered in this study are presented in Table 2. PCV value was generally higher than their corresponding GCV values for all the characters considered indicating the higher influence of environment on germplasm accessions for expression of these characters. According to Deshmukh *et al* [9] PCV and GCV values greater than 20% are regarded as high, whereas values less than 10% are considered to be low and values between 10% and 20% to be medium. Based on these delineation, PCV and GCV values were high for bearing tiller, leaf area, ash and crud fiber content. PCV values were high but GCV values were medium for diameter of dry capsule, total tiller per plant, length of dry capsule, volatile oil content, length of fresh capsule, weight of dry capsule and yield per plant. In addition PCV values were medium for number of leaf per stem and plant height whereas the GCV values were low for these characters. The GCV and PCV value were medium for number of capsule per plant, oleoresin content, and diameter of fresh capsule and weight of fresh capsule.

This medium to high GCV values of these characters suggest that the possibility of improving these trait through

selection. The PCV and GCV values were low for crud fat content indicating difficulty of improvement through selection.

This result is in harmony in high volatile oil content and medium plant height and oleoresin content with the work of Momina *et al* [7], however they found GCV and PCV value of medium leaf area and high number of leaf per stem which is low and medium for number of leaf per stem respectively and high leaf area for both obtained in the present study. In contrast to this Yudhvir *et al* [10] obtained medium to high GCV and PCV value for plant height, leaf number and tiller number in turmeric.

The difference between PCV and GCV values was high for total tiller, weight of fresh capsule, length of fresh capsule, weight of dry capsule, length of dry capsule and volatile oil content; indicating influence of environment on these characters.

However, this difference was relatively low for plant height, bearing tiller, number of leaves per stem, leaf area, number of capsule per plant, diameter of fresh capsule, diameter of dry capsule, oleoresin content, ash, crud fiber and fat contents; showing minimum influence of environment on the expression of the characters. Konda *et al* [11] obtained the same result for plant height, number of capsule per plant and crud fiber content in blackgram.

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Table 2: Estimates of genetic parameters for twenty one characters of korarima germplasms

	Range			Genetic Parametres						
Traits	**Min**	**Max**	**Mean**	$\sigma^2 g$	$\sigma^2 p$	**GCV%**	**PCV%**	**H^2**	**GA**	**GAM%**
BT	1	4	2.49	0.51	0.73	28.7	34.3	69.9**	8.4	337.34
ASH	1.2	3.6	2.23	0.332	0.48	25.8	31	69.5**	8	358.7
CRFI	10.1	37.85	20.12	18.95	29.7	21.6	27.1	63.9**	6.8	34
NCPP	5	10.8	8.12	1.48	2.58	15	19.8	57.4**	5.3	65.3
OC	3.2	7.2	4.64	0.391	0.76	13.5	18.7	51.7**	4.6	99.4
DFC	7.6	14.8	10.92	1.64	2.59	11.7	14.7	63.3**	5	45.9
DDC	3.6	10.8	6.92	1.69	2.64	18.7	23.5	64**	6.4	92
TT	4	13	7.12	1.82	4.1	18.9	28.5	44.2*	4.9	68.3
LDC	2	8.2	4.28	0.37	0.87	14.2	21.8	42.5*	4.1	96
VOC	1.1	3.5	2.23	0.17	0.36	18.5	26.9	47.2*	5	224.2
WFC	12.5	32.02	23.06	7.96	20.5	12.2	19.3	38.8*	3.5	15.4
LFC	4	13.4	7.6	1.61	4.5	16.7	27.8	36.1*	3.9	51.3
WDC	6.5	17.1	11.69	3.02	6.34	14.9	21.5	47.3*	4.6	39
NLPS	18	35.2	27.04	6.13	13.4	9.2	13.5	45.7*	3.5	12.8
PH	118.2	221	173.1	225.35	444.41	8.7	12.2	50.7**	3.6	2.1
LA	78.4	248.6	162.02	1070.81	1755.9	20.1	25.9	61**	6.4	3.9
CRFAT	2.12	2.9	2.38	0.015	0.04	5.1	7.97	41.7*	2.4	100.8
YPP	168.4	374.3	277.92	2038.99	3846.6	16.2	22.3	53**	5.16	1.9

** And * indicates high and medium heritability values respectively

GV:genetic variance, PV: phenotypic variance, GCV: genotypic coefficient of variation, PCV: phenotypic coefficient of variation, H^2:heritability in broad sense: GA: genetic advance, GAM%: genetic advance under percent mean PH: plant height, TT:total tiller, BT: bearing tiller, NLPS: number of leaf per stem, LA: leaf area, NCPP: number of capsule per plant, YPP: yield per plant, WFC: weight of fresh capsule, LFC: length of fresh capsule, DFC: diameter of fresh capsule, WDC: weight of dry capsule, LDC: length of dry capsule, DDC: diameter of dry capsule, CRFI%: crud fiber percentage, VOC: volatile oil content, OC: oleoresin content, %ASH: percent ash content, CRFAT%: crud fat percentage

Heritability and genetic advance estimate for all the characters are presented in Table 2. In this finding estimate of heritability in the broad sense ranged from 36.1% for length of fresh capsule to 69.9% for bearing tiller.

According to Verma and Agarwal [12] heritability value greater than 50% are considered as high whereas values less than 20% are low and values between 20% and 50% as medium. Accordingly high heritability was estimated for plant height (50.7%), bearing tiller (69.9%), leaf area (61%), number of capsule per plant (57.4%),yield per plant (53), diameter of fresh capsule (63.3%), diameter of dry capsule(64%), oleoresin content (51.7%), ash and crud fiber content with the values of (69.5 and 62.7%) respectively. Whereas medium for total tiller (44.2%), number of leaf per stem (45.7%), weight of fresh capsule (38.8%), length of fresh capsule (36.1%), weight of dry capsule (47.3%), length of dry capsule (42.5%), volatile oil content (47.2%), crud fat (41.7%). This medium and high heritability indicating the possibility of progress from selection. This finding is in agreement with the finding of Prasath D and MN Venugopal [13] for plant height, total tiller, bearing tiller and number of capsule per plant in cardamom. Yudhvir *et al* [10] also obtained high heritability for tiller number, leaf number and plant height in turmeric.

The genetic advance as the percentage of mean (GAM) at 5% selection intensity is presented in table 2. According to Johnson *et al* [14] genetic advance said to be high if its value is greater than or equal to 20%, medium between 10-20% and low when it is less than 10%. Based on this criteria high genetic advance as percent mean was observed for total tiller, bearing tiller, number of capsule per plant, length of fresh capsule, diameter of fresh capsule, length of dry capsule, diameter of dry capsule, volatile oil, oleoresin, ash, crud fiber and crud fat content. Genetic advance as percent of mean for number of leaf per stem and weight of fresh capsule was medium. Whereas genetic advance as percent mean is low for plant height, leaf area and yield per plant.

According to Johnson *et al* [14] high heritability estimates along with the high genetic advance is usually more helpful in predicting gain under selection than heritability estimates alone Therefore in this study most of the character had high genetic advance as percent mean in conjunction with medium to high heritability indicating the characters could be improved easily and emphasis should be placed on those characters for formulating reliable selection indices (for example; bearing tiller, ash, crud fiber, oleoresin content and number of capsule per plant) for the development of high yielding genotypes.

This finding is closely in agreement to the work of Nirmal Baru *et al* [15] on plant height, number of leaf per stem and total tiller in turmeric. On the other hand plant height showing low genetic advance as percent mean (< 5%) in conjunction with low heritability. This is because of low GCV value of the character indicating the characters are under higher influence of environment and that selection based on these characters would be ineffective.

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