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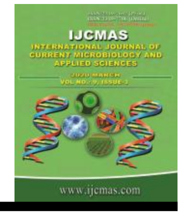

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Association and Path Analysis in Lentil (*Lens culinaris* M.) Genotypes for Seed and Seedling Characteristics

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A B S T R A C T

Thirty genotypes of lentil were evaluated for their seed and seedling characteristics in randomized block design with three replications to study the association and path analysis for different characters. Observations were recorded on 100 seed weight, seed volume, true density, bulk density, porosity, water absorption capacity, water absorption index, germination, seedling length, seedling fresh weight, seedling dry weight and seedling vigour index. The association analysis revealed that the 100 seed weight was positively and significantly correlated with seed volume, water absorption capacity and seedling dry weight, whereas water absorption index, seedling length and seedling vigour index had negative and significant correlation with 100 seed weight. Path analysis was carried out by taking 100 seed weight as dependent variable and other traits as independent variables. The direct and positive effect on 100 seed weight was recorded for water absorption capacity, seed volume, seedling vigour index, porosity, bulk density, seedling fresh weight and seedling dry weight, while negative direct effect were exhibited by true density, germination per cent, seedling length and water absorption index.

Introduction

Lentil belongs to family Fabaceae (Leguminosae) and subfamily Papilionaceae. Genus *Lens* consists of the cultivated *Lens culinaris* and six related wild taxa. Among these different taxa of wild lentils, *L. orientalis* is considered to be the progenitor of the cultivated lentil. According to Ladizinsky (1979)lentil has been originated in Southern Turkey. Lentil thrives well in sub-marginal lands with low inputs under water- limited conditions and has great importance in cereal-based cropping systems. The seed of this plant are commonly used as edible pulse and largely consumed as *dal* and also used in soups, stews, salads, casseroles, snacks and vegetarian dishes. Lentil contains high lysine and tryptophan content and is consumed with wheat or rice which provides a balance in essential amino acids for human nutrition. Lentil is known as poor man's meat. Nutritionally lentil seeds are valued for their high protein content (as much as 30%) and good source of vitamins and other important minerals (K, P, Fe, Mg, Zn), low in fat and cholesterol free. Lentil seeds contain about 25-27% crude protein, 59% carbohydrates, 0.5% fat, 2.1% minerals and significant amount of vitamins (Gowda and Kaul, 1982). Lentil is mainly grown in India, Canada, Turkey, USA, Syria and Australia. India has a distinction of being the world's largest producer of pulses and occupies second position in the world with respect to lentil production. Major lentil growing states are Madhya Pradesh, Uttar Pradesh, Bihar and West Bengal. The broad knowledge of physical properties of agricultural products is being used in farming, planting, harvesting, processing, storage and transportation. Scientists from different corners of the world, have made high efforts in evaluating physical properties of agricultural products and found out their practical utility in designing and handling equipments and machineries(Waziri & Mittal, 1983). Recent scientific research and developments have made improvement in the handling and processing of biological materials through mechanical, thermal, electrical, optical and other techniques, but there is little knowledge about the basic physical characteristics of agricultural products. Such basic information is important to food scientists, processors, plant breeders and other scientists who may find new uses (Mohesenin, 1986).The purpose of this research work was to investigate the association among different seed and seedling characteristics and their direct and indirect effects on component characters of the lentil genotypes to assist the breeding strategies for increasing the production of pulses including development and utilization of improved varieties, production technologies and plant protection measures which are expected to reduce the existing knowledge gap in the production and requirement of pulses.

Materials and Methods

The experiment was carried out in the Laboratory of Department of Plant Breeding and Genetics, Sri Karan Narendra College of Agriculture, Jobner (SKNAU, Jobner, Rajasthan) during the period from October, 2017 to April, 2018. The experiment was conducted under laboratory conditions at room temperature where the temperature was maintained at 24±2 ^{0}C.Glass petridishes were used in the experiment after sterilization in hot air oven at 165^{0}C for 4 hours (Sharma and Yadav, 2016). The germination papers were autoclaved at 15 psi and 121^{0}C for 20 minutes and used as a matrix for seed germination. Thirty genotypes of lentil (Table1.) were obtained from AICRP on MULLaRP at Rajasthan Agricultural Research Institute, Durgapura, Jaipur. Uniformly selected seeds were sterilized with 0.1% mercuric chloride for 1 minute and then washed repeatedly for two to three times under running tap water followed by washing with distilled water. After that the seeds were ready for placing in the petridishes. The disinfected seeds were planted in petridishes and were maintained in controlled laboratory conditions. The germination was completed within 6 days of planting and monitored on 7thday from the day of seed planting.Observations ondifferent seedling characters *viz*., seedling length, seedling fresh weight, seedling dry weight, and seedling vigour index were recordedon randomly selected seedlings on 11th day of seed planting. The data on seedling dry weight was recorded after drying in hot air oven for 48 hours at 65^{0}C.

Observations recorded for seed characteristics

To determine 100 seed weight (g), a sample of one hundred seeds was drawn from each replication and weighed on an electronic balance.Seed volume was measured by liquid displacement technique (Shepherd and Bhardwaj, 1986). For each lentil genotype from each replication 100 seeds were weighed and put into a 100 ml measuring cylinder containing 15 ml (initial reading) of water that could completely cover all the seeds. Seed volume was recorded as (final reading – initial reading)/100 (Mohsenin, 1986) and expressed as (µl/seed).

The true density (g/cm$^{3)}$ was determined by dividing individual seed weight (g) by its volume which was measured already in cm^3. To measure bulk density, a rectangular container was weighed in gram (W_1) and the seeds of each replication was filled in this container and weighed with container (W_2) by using electronic balance. The bulk density of seed was measured by dividing the mass of seed (g) by volume of the container (cm^3) by using following formulae (Khattak *et al.*, 2006):

$$\text{Bulk density (g/cm}^3\text{)} = \frac{M}{V}$$

Where, M = Mass of seed (W_2 - W_1) in grams

V = Volume of container in cm^3

The porosity (ε) of bulk seed was computed from the values of the true density (ρ_t) and bulk density (ρ_b) using the following formula (Singh and Goswami, 1996):

$$\text{Porosity (\%)} = \{1 - \frac{\rho b}{\rho t}\} \text{ X } 100$$

The water absorption capacity was determined by weighing100 seeds from each replication, soaked in water and was maintained at a temperature of 22° C for 12 hours. The seeds were then removed from water and the excess moisture on the seed surface was removed by using filter paper and seeds were weighed. Water absorption capacity in terms of mg per seed was recorded as per Mohsenin (1986)formula:

$$\text{WAC (mg/seed)} = \frac{\text{Weight after soaking - Weight before soaking}}{100}$$

Where, WAC = Water absorption capacity

Water absorption index was obtained by dividing the water absorption capacity of a single seed by its size or weight (Williams*et al.*, 1983).

$$\text{Water absorption index} = \frac{\text{Water absorption capacity (mg/seed)}}{\text{Original seed size (g)}}$$

Observations recorded for seedling characteristics

A seed was considered to have germinated at the emergence of both radicle and plumule up to 2 mm length (Chartzoulakis and Klapaki, 2000). The number of germinated seeds was recorded 7th day after plating of seeds in petridishes and thegermination percentage was determined by using the following formula (Aniat *et al.*, 2012):

$$\text{Germination Percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds planted}} \times 100$$

The seedling length of germinated seeds was recorded on 11th day of plating in petridishes. Five seedlings from each petridish were randomly selected from each replication. The seedling length (the distance from root tip to leaf tip) was measured by using a measuring scale in centimeter and averaged. The fresh weight of five seedlings from each replication was taken by using a sensitive electronic balance and average was expressed in milligram (mg).

To obtain seedling dry weight, freshly weighed same five seedlings were kept in oven at 65^{0}C for 48 hours for drying. After drying, the dried seedlings were weighed using sensitive electronic balance in milligram and averaged. The seedling vigour index was determined by multiplying the seedling length with concerned germination percentage by the following formula (Iqbal and Rahmati, 1992):

$$\text{Seedling Vigour Index (SVI)} = (SL) \times (GP)$$

Where, SL= Mean seedling length (cm)

GP= Germination percentage

Results and Discussion

In general, correlation and path coefficients were stronger at phenotypic level in comparison to genotypic level; this indicated the strong effect of environment on the expression of the characters. Significance was tested at phenotypic level only. The association and path coefficient at phenotypic level are generally considered as there is no tangible test for knowing the statistical significance of correlation and path coefficient at genotypic level (Reddy and Sharma, 1982 and Singh *et al*. 1998). Considering this reference, association and path analysis at phenotypic level is described here.

Character association analysis

Association analysis provides information about degree and direction of association between two characters. It may result due to genetic causes such as pleiotropic effect or linkage or both. It may also be due to environmental cause. Improvement in one character may cause simultaneous change in other characters and may be judged by the magnitude and direction of correlation.

Phenotypic correlation coefficients among twelve characters are presented in table2.In this study, the 100 seed weight had positive and significant association with seed volume (0.828), water absorption capacity (0.942), and seedling dry weight (0.685). The seed volume had positive and significant association with water absorption capacity (0.804), seed weight (0.828) and seedling dry weight (0.739). The water absorption capacity had positive and significant association with seed weight (0.942), seed volume (0.804) and seedling dry weight (0.696).Williamsa *et al*. (1983), Khattak *et al*. (2006), Paksoy and Aydin (2006), Makkawi *et al*. (2008), Malik *et al*. (2011), Nichal *et al.* (2015) and Hadi *et al*. (2016) also reported similar results for these characters. The true density had positive and significant association with porosity (0.942). The bulk density had negative and significant association with seed volume (-0.213) and water absorption capacity (-0.210). The porosity had positive and significant association with true density (0.942).Similar findings were reported earlier by Williams *et al*. (1983)and Hadi *et al*. (2016)for true density and water absorption capacity.The water absorption index showed negative and significant association with seed weight (-0.257) and the germination percentage showed negative and significant association with true density (-0.233) and porosity (-0.249). The seedling fresh weight had positive and significant association with seedling length (0.541) and seedling vigour index (0.516). The seedling dry weight had positive and significant association with seed weight (0.685), seed volume (0.739), and water absorption capacity (0.696). The seedling length had positive and significant association with seedling fresh weight (0.541) and seedling vigour index (-0.975) which was also reported by Latha (2014). In this study, the seedling vigour index showed negative and significant correlation with seedling dry weight which was contradictory to the findings of Nichal *et al.* (2015)who reported the positive and significant correlation between seedling vigour index and seedling dry weight.

Path coefficient analysis

Path coefficient analysis helps in separating the direct effects of a component character on a dependent character from indirect effects via other characters. In the present study 100 seed weight was considered as dependent variable. The correlation coefficients of 100 seed weight with its contributing characters were partitioned into direct and indirect effects through path coefficient analysis and are presented in table 3 at phenotypic levels. The trend in direct and indirect effects of different traits on 100 seed weight was similar at genotypic and phenotypic levels.

Seven out of eleven characters had positive and direct effect on 100 seed weight at phenotypic level. The highest direct and positive effect on 100 seed weight was recorded for water absorption capacity (0.72428) and succeeded by seed volume (0.28821), seedling vigour index (0.22186), porosity (0.19216), bulk density (0.05479), seedling fresh weight (0.01597) and seedling dry weight (0.00388), while true density (-0.02702), germination per cent (-0.04102), seedling length (-0.22534) and water absorption index (-0.24809) had negative direct effect on 100 seed weight. The detail is given in table 4.

The seed volume showed positive indirect effect on 100 seed weight through water absorption capacity (0.58206), seedling length (0.05966), water absorption index (0.03653), true density (0.01414), seedling dry weight (0.00287) and seedling fresh weight (0.00268), whereas negative indirect effect through germination (-0.00608), bulk density (-0.01165), seedling vigour index (-0.05044) and porosity (-0.09046).

The true density showed positive indirect effect on 100 seed weight through porosity (0.18101), water absorption index (0.01940), seedling length (0.01567), germination (0.00956), bulk density (0.00896) and water absorption capacity (0.00676), whereas negative indirect effect through seedling fresh weight (-0.00028) and seedling dry weight (-0.00103), seedling vigour index (-0.02596) and seed volume (-0.15076).

The bulk density showed positive indirect effect on 100 seed weight through water absorption index (0.03801), seedling length (0.00407) and seedling fresh weight (0.00151), whereas negative indirect effect through and seedling dry weight (-0.00033), seedling vigour index (-0.00162), germination (-0.00163), true density (-0.00442), porosity (-0.02957), seed volume (-0.06129) and water absorption capacity (-0.15189).

The porosity showed positive indirect effect on 100 seed weight through water absorption capacity (0.03436), water absorption index (0.01868), germination (0.01020) and seedling length (0.00695), whereas negative indirect effect through seedling fresh weight (-0.00033), seedling dry weight (-0.00101), bulk density (-0.00843), seedling vigour index (-0.01837), true density (-0.02546) and seed volume (-0.13567).

The water absorption capacity showed positive indirect effect on 100 seed weight through seed volume (0.23162), seedling length (0.08462), seedling dry weight (0.00270), seedling fresh weight (0.00198) and porosity (0.00912), whereas negative indirect effect through true density (-

0.02546), germination (-0.01020), bulk density (-0.00843), water absorption index (-0.01868), and seedling vigour index (-0.01837).

The water absorption index showed positive indirect effect on 100 seed weight through water absorption capacity (0.05736), seedling length (0.00954) and true density (0.00211), whereas negative indirect effect through seedling dry weight (-0.00012), germination (-0.00235), seedling fresh weight (-0.00291), seedling vigour index (-0.00687), bulk density (-0.00840), porosity (-0.01447) and seed volume (-0.04243).

The germination showed positive indirect effect on 100 seed weight through seedling vigour index (0.04485), seed volume (0.04271) water absorption capacity (0.0245), true density (0.00630), seedling length (0.00389), bulk density (0.00217) and seedling dry weight (0.00054), whereas negative indirect effect through seedling fresh weight (-0.00121), water absorption index (-0.01423) and porosity (-0.04478).

Table.1 List of genotypes used in the experiment

S.No.	Genotype	S.No.	Genotype
1	RLG – 43	16	RLG – 257
2	RLG – 191	17	RLG – 258
3	RLG – 223	18	RLG – 234
4	RLG – 224	19	RLG – 195
5	DPL – 58	20	RLG – 255
6	RLG – 147	21	RG – 254
7	RLG – 48	22	RLG – 5
8	RLG – f8(3)	23	SAPNA
9	RLG – 245	24	RLG – 273
10	RLG – 261	25	RLG – 279
11	DPL – 62	26	RLG – 270
12	LG – 262	27	RLG – 283
13	RLG – 250	28	RLG – 274
14	RLG – 256	29	RLG – 281
15	RLG – 266	30	RLG – 276

Table.2 Phenotypic correlation coefficients for various characters in lentil

Characters	SW	SV	TD	BD	Por	WAC	WAI	Germ	SL	SFW	SDW
SV	0.828**										
TD	0.036	-0.523**									
BD	-0.152	-0.213*	0.163								
Por	0.073	-0.471**	0.942**	-0.154							
WAC	0.942**	0.804**	0.009	-0.210*	0.047						
WAI	-0.257*	-0.147	-0.078	-0.153	-0.075	0.079					
Germ	0.021	0.148	-0.233*	0.040	-0.249*	0.034	0.057				
SL	-0.343**	-0.265*	-0.070	-0.018	-0.031	-0.374**	-0.042	-0.017			
SFW	0.196	0.168	-0.017	0.095	-0.021	0.124	-0.182	-0.076	0.541**		
SDW	0.685**	0.739**	-0.265*	-0.084	-0.261*	0.696**	-0.031	0.138	-0.392**	-0.032	
SVI	-0.330**	-0.227*	-0.117	-0.007	-0.083	-0.358**	-0.031	0.202	0.975**	0.516**	-0.353**

* and ** represent significant at 5% and 1% level of significance, respectively.
Note: SW = 100 seed weight, SV = seed volume, TD = true density, BD = bulk density, Por = porosity, WAC = water absorption capacity, WAI = water absorption index, Germ = germination, SL = seedling length, SFW = seedling fresh weight, SDW = seedling dry weight and SVI = seedling vigour index

Table.3 Phenotypic path coefficients for various characters in lentil

Ch.	SV	TD	BD	Poro	WAC	WAI	Ger	SL	SFW	SDW	SVI	100 SW
SV	**0.28821**	0.01414	-0.01165	-0.09046	0.58206	0.03653	-0.00608	0.05966	0.00268	0.00287	-0.05044	0.828**
TD	-0.15076	**-0.02702**	0.00896	0.18101	0.00676	0.0194	0.00956	0.01567	-0.00028	-0.00103	-0.02596	0.036NS
BD	-0.06129	-0.00442	**0.05479**	-0.02957	-0.15189	0.03801	-0.00163	0.00407	0.00151	-0.00033	-0.00162	-0.152NS
Poro	-0.13567	-0.02546	-0.00843	**0.19216**	0.03436	0.01868	0.0102	0.00695	-0.00033	-0.00101	-0.01837	0.073NS
WAC	0.23162	-0.00025	-0.01149	0.00912	**0.72428**	-0.01965	-0.00139	0.08426	0.00198	0.00270	-0.07951	0.942**
WAI	-0.04243	0.00211	-0.0084	-0.01447	0.05736	**-0.24809**	-0.00235	0.00954	-0.00291	-0.00012	-0.00687	-0.257*
Ger	0.042710	0.0063	0.00217	-0.04778	0.0245	-0.01423	**-0.04102**	0.00389	-0.00121	0.00054	0.04485	0.021NS
SL	-0.07630	0.00188	-0.00099	-0.00593	-0.27083	0.01051	0.00071	**-0.22534**	0.00864	-0.00152	0.2163	-0.343**
SFW	0.04835	0.00047	0.00519	-0.00396	0.0896	0.04514	0.0031	-0.12187	**0.01597**	-0.00013	0.11452	0.196NS
SDW	0.21308	0.00716	-0.00461	-0.05014	0.50441	0.00778	-0.00566	0.08831	-0.00052	**0.00388**	-0.07826	0.685**
SVI	-0.06552	0.00316	-0.0004	-0.01591	-0.25958	0.00768	-0.00829	-0.21969	0.00824	-0.00137	**0.22186**	-0.330**

* and ** represent significant at 5% and 1% level of significance, respectively.

Note: SW = 100 seed weight, SV = seed volume, TD = true density, BD = bulk density, Por = porosity, WAC = water absorption capacity, WAI = water absorption index, Germ = germination, SL = seedling length, SFW = seedling fresh weight, SDW = seedling dry weight and SVI = seedling vigour index

The seedling length showed positive indirect effect on 100 seed weight through seedling vigour index (0.2163), water absorption index (0.01051), seedling fresh weight (0.08640), true density (0.00188) and germination (0.00071), whereas negative indirect effect through bulk density (-0.00093), seedling dry weight (-0.00152), porosity (-0.00593), seed volume (-0.07630) and water absorption capacity (-0.27083).

The seedling fresh weight showed positive indirect effect on 100 seed weight through seedling vigour index (0.11452), water absorption capacity (0.0896), seed volume (0.04835), water absorption index (0.04514), bulk density (0.00519), germination (0.00310) and true density (0.00047), whereas negative indirect effect through seedling dry weight (-0.00013), porosity (-0.00396) and seedling length (-0.12187).

The seedling dry weight showed positive indirect effect on 100 seed weight through water absorption capacity (0.50441), seed volume (0.21308), seedling length (0.08831), water absorption index (0.00778) and true density (0.00716), whereas negative indirect effect through seedling fresh weight (-0.00052), bulk density (-0.00461), germination (-0.00566), porosity (-0.05014) and seedling vigour index (-0.07826).

The seedling vigour index showed positive indirect effect on 100 seed weight through seedling fresh weight (0.00824), water absorption index (0.00768) and true density (0.00316), whereas negative indirect effect through bulk density (-0.0004), seedling dry weight (-0.00137), germination (-0.00829), porosity (-0.01591), seed volume (-0.06552), seedling length (-0.21969) and water absorption capacity (-0.25958). There is a little research work for this objective of study but some related findings were reported by Honnappa *et al*. (2018).

In conclusion, information on physical properties of seeds of various genotypes may be helpful in designing desirable machines and equipments to be used during seed processing and safe storing of the seed. Selection based on high 100 seed weight, seed volume, water absorption capacity, true density, porosity, seedling length, seedling fresh weight, seedling dry weight and seedling vigour index may play an important role on these aspects in lentil.

References

Aniat, U.H., Vamil, R. and Agnihotri, R.K. (2012). Effect of osmotic stress on germination and seedling survival of lentil (*Lens culinaris* M.). *Research in Agricultural Science*,1: 201-202.

Chartzoulakis, K.S. and Klapaki, G. (2000).Response of two greenhouse pepper hybrids to NaCl salinity during different growth stages. *Scientia Horticulture*,86: 247-260.

Gowda, C.L.L. and Kaul, A.K. (1982). Pulses in Bangladesh, Bangladesh Agricultural Research Institute (BARI) and FAO publication, pp. 2.

Hadi, M., Khodambash, M. and Shiran, B. (2016). Evaluation of seed characteristics in three lentil (*Lens culinaris* M.) genotypes. *Scientia Agriculture*,13: 80-84.

Honnappa, Mannur, D. M., Hosamani, M., Umesh Babu, B. S. and Archana, K. A. (2018). Characterization, association and path analysis studies of different cooking quality/ physicochemical parameters in green seeded chickpea genotypes. *Journal of Pharmacognosy and Phytochemistry*,7: 2027-2033.

Iqbal, M.Z. and Rahmati, K. (1992). Tolerance of A*lbizia lebbeck* to Cu and Fe application. *Ekologia CSFR*, 1: 427-430.

Khattak, A.B., Khattak, G.S.S., Mahmood, Z., Bibi, N. & Ihsanullah, I. (2006). Study of selected quality and agronomic characteristics and their interrelationship in Kabuli-type chickpea genotypes (*Cicer arietinum* L.). *International Journal of Food Science and Technology*, 41: 1–5.

Ladizinsky, G. (1979). The origin of lentil and its wild gene pool. Euphytica, 28: 179-187.

Latha, C. N. (2014). Evaluation of seed characters and their relationships with seed quality in chickpea (*Cicer arietinum* L.) genotypes. Department of Seed Science and Technology, University of Agricultural Sciences, Bangalore, M.Sc. Thesis.

Makkawi, M., Balla, M. E., Bishaw, Z. and Gastel, A.J.G.V. (2008). Correlation and path coefficient analyses of laboratory tests as predictors of field emergence in lentil (*Lens culinaris* M). *Journal of New Seeds*, 9: 284-302.

Malik, S.R., Saleem, M., Iqbal, U., Zahid, M.A., Bakhsh, A and Iqbal S.M. (2011). Genetic analysis of physiochemical traits in chickpea (*Cicer arietinum*) seeds. *International Journal of Agriculture & Biology*, 13: 1033–1036.

Mohsennin N.N. (1986). Physical properties of plants and animal materials. Gordon and Breach Science Publishers, New York.

Nichal, S. S., Chawhan, R. G., Tayade, S. D. and Ratnaparkhi, R. D. (2015). Correlation of seed and seedling characters with yield of sunflower (*Helianthus annuus* L.) hybrids.*International Journal of Economic Plants*,1:065-068.

Paksoy, M. and Aydin, C. (2006). Determination of some physical and mechanical properties of pea (*Pisum sativum.* L.) seed. *Pakistan Journal of Biological Sciences*,9: 26-29.

Reddy, N.S. and Sharma, R.K. (1982). Variability and interrelationship for yield and protein content in inbred lines of bajra. *Crop Improvement*,9: 124-128.

Sharma, S. and Yadav, V. (2016). Effect of salt stress on germination and growth of *Trigonella foenum graecum* seedlings. *International Journal of Advanced Research*, 4: 40-45.

Shepherd, H., Bhardwaj, R. K. (1986). Moisture-dependent physical properties of pigeon pea. *Journal of Agricultural Engineering Research*,35: 227–234.

Singh, K.K. and Goswami, T.K. (1996). Some physical properties of cumin seed (*Cuminum cyminum* L.). *Journal of Food Engineering Research*, 64: 93-98.

Singh, R.P., Garg, D.K. and Sharma, P.C. (1998). Character association in wheat. *Indian Journal of Genetics*,58: 219-22.

Williamsa, P.C., Nakoul, H. and Singh, K.B. (1983). Relationship between cooking time and some physical characteristics in chickpeas *(Cicer arietinum* L.). *Journal of the Science of Food and Agriculture*,34: 492-496.

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