WFL **Publisher**
Science and Technology

Meri-Rastilantie 3 B, FI-00980
Helsinki, Finland
e-mail: info@world-food.net

Journal of Food, Agriculture & Environment Vol.8 (2): 876-881. 2010 *www.world-food.net*

The morphological characterization of caper plant (*Capparis* ssp.) in North Morocco

Naoual Saifi [1, 2], Ghizlane Echchgadda [1] and Jamal Ibijbijen [2]

[1] Department of Plant Protection and Environment, Nationl School of Agriculture, P. O. Box 40 Meknes, Morocco. [2] Departement of Biology, Faculty of Sciences, Moulay Ismail University, P. O. Box 4010 Beni M'homed, Meknes, Morocco.
e-mail: saifinaoual@yahoo.fr, gechchgadda@yahoo.fr, jamalibijbijen@yahoo.fr

Received 16 December 2009, accepted 10 April 2010.

Abstract

The caper is a small perennial shrub of the Capparidaceae family and the *Capparis* genus. It is abundantly found throughout different regions of Morocco. The flower buds, fruits and shoots are commonly used by the local population and the traditional healers for treatment of several diseases. The aims of this work consists of a morphological characterization of some populations of caper plant, which would be a necessary precondition to study the genetic structure of these species and to identify the prevailing varieties in order to improve them. The species and varieties of *Capparis* occurring in Morocco and particularly those growing in Northern Morocco (Regions Fes, My Idriss, Taounate) are reviewed here, a statistical approach is adopted to clarify their phylogenetical relations as well as an attempt to identify their taxonomy following the taxonomy of Zohary.

Key words: *Capparis* ssp., biodiversity, morphological characterization, phylogeny.

Introduction

In the Capparidaceae family, the *Capparis* genus comprises a large number of species (about 250 species) distributed in tropical and subtropical regions of the old and the new world [1]. Zohary [2] described six species and 15 varieties from the Mediterranean region and the Near Est, while Jacob [3] in a revision of mainly East Asian material, recognized *Capparis spinosa* as a single species that includes all of Zoharys taxa [4]. In Europe, Heywood [5] recorded two species: *Capparis spinosa* and *Capparis ovata*. More recently, Higton and Akeryod [4] and Heywoode [6] incorporated all the populations from the continent within *Capparis spinosa* divided into subsp.*spinosa* and subsp.*rupestris* (sibth and sm.) Nyman [7]. In Sicily, the coexistence of the two forms has been documented by Fici and Gianguzzi [1]. In Morocco there has been little studies of *Capparis* since the publication of the studies by Fennane *et al.* [8] and Benabid [9], which recognized two species, *Capparis spinosa* L and *Capparis deciduas* (Forsk) Edgew. Fennane [8] noted that *Capparis spinosa* shows a marked high degree of heterogeneity. He believes that the conclusions of the study relating to the morphology of the caper plant in Europe apply partially to the Moroccan material. Inocencio *et al.* [10] reported that Morocco contains four varieties, namely *Capparis ovata* Desf var.*sicula* (Duham) Zoh (fes, sidi-kacem), *Capparis ovata* Desf. var. *ovata* (zaio, Driouch), *Capparis spinosa* L.var. *intermis* Turra (zaio, Driouch) and *Capparis spinosa* L.var. *aegyptia* (Safi, Tizi-n-test, Asni). The study of the variations of these species still remains to be conducted. The present paper reassessed the taxonomy of *Capparis* spp. in Morocco and particularly those growing in Northern Morocco, as well as re-evaluated their phylogenetical relationship. The area in question (Northern Morocco) was chosen due to its ability to produce more than 70% of the national production of capers [11].

Materials and Methods

An extensive field examination of plant material was carried out in Northern Morocco from 2005 to 2007 (Table 1). Six quantitative (Table 2) and 7 qualitative (Table 3) characters were measured and marked from 100 tagged individuals.

These characters represent aspects of growth habit and vegetative parts. Among them, BF/R is the number of flower buds per branch; Lpt/L is the ratio between length of petiole and that of leaf. CF is the leaf colour, FF is the leaf shape, CT is the stem colour. The data were collected on mature leaves and mature flower buds, while the stems were measured at the middle of their development (May-July). For each character, five replicates per individual were measured and noted, and the average was used in the subsequent analysis. The signification of the quantitative characters was tested by ANOVA. The ANOVA test, cluster analysis based on the quantitative and qualitative characters and principal component analysis (PCA) were also carried out using XLSTAT 2008 software (http: www.xlstat.com). Cluster analysis was based on a Euclidian distances matrix, and a dendrogram was obtained by UPGMA as cluster algorithm. In this work the adopted nomenclature follows Zohary [2].

Results

The length of stipule, the flower bud, and leaf morphology are very variable. The ANOVA test revealed significant differences ($p < 0.0001$) between the different groups of individuals existing in different areas of the case study (Appendix 1). The caper (*Capparis* spp.) variability analysis by morphological descriptors revealed an important polymorphism. Regarding PCA (Fig. 1), in the two scatter plots, we can observe several clusters. The first principal component accounted for 46.23% of the total variability and the second principal component accounted for 26.49%

Table 1. Location of the 20 populations studied.

Area	Station
My Idriss	1. Nezala beni Amar "S1"
	2. Nezala beni Amar "S2"
	3. Mekkess "S1"
	4. Mekkess "S2"
	5. Bakchou
Taounate	6. Tissa "S1"
	7. Tissa "S2"
	8. Tissa "S3"
	9. Tissa "S4"
	10. Karya
	11. Inaoune
Fés	12. Fés city
	13. Ain Kanessera
	14. Zewagha My Yaakoub
	15. Elaâjajera "S1"
	16. Elaâjajera "S2"
	17. Sidi daoude
	18. Oulja
	19. Oulad tahar
	20. Pont du sabou

S: Station.

Table 2. Characters used in the quantitative morphological analysis.

Vegetative part	Code	Character	Units
Flower bud	BF/R	Number of flower buds per branch	count
	PBF	Weight of the flower bud	g
	LBF	Width of the flower bud	mm
	lBF	Length of the flower bud	mm
Stem	LE	Length of stipule	mm
Leaf	Lpt/L	Ratio between length of petiole and length of leaf	mm/ mm
			mm/ mm

Table 3. Characters used in the qualitative morphological analysis.

Vegetative part	Code	Character
Flower bud	FBF	Flower bud shape
	CBF	Flower bud colour
Stem	CF	Stipule colour
	CT	Stem colour
Leaf	CF	Leaf colour
	SF	Leaf top
	FF	Shape leaf shape

(Appendix 2). The results of this characterization show the existence of three species: *Capparis cartilaginea* Decne, *Capparis ovata* Desf and *Capparis spinosa* L. For the two last taxa, the phenotypical variability is very important. The distribution of the three taxa in Northern Morocco (Fés, Taounate and My Idriss Zerhoune) reflects their different substratum specializations. The dendrogram obtained from cluster analysis (degree of dissimilarity = 50) (Fig. 2) shows this remarkable phenotypic plasticity, linked to edaphically area condition. Eight clusters of plant, which we shall refer to as ecotypes I-VIII, can be seen in Table 4.

Discussion

Zohary [2] reported that he also found the *Capparis cartilaginea* Decne to Socotra, Egypt, Sinai, Afghanistan and Baluchistan. We observed the same specimen in Northern Morocco and in the national herbarium (National Museum, Rabat) under the name *Capparis galeta*, with heart-shaped leaves. *Capparis ovata* Desf, in the case study, is represented by three varieties: *Capparis ovata* Desf. var. *sicula* (Duham) Zoh, *Capparis ovata* Desf.var. *herbacea* (Willd) Zoh, *Capparis ovata* Desf. var. *ovata*. *Capparis spinosa* L. is represented by four varieties: *Capparis spinosa* L. var. *intermis* Turra, *Capparis spinosa* L.var.*spinosa*, *Capparis spinosa* L.var. *aegyptia* and *Capparis spinosa* L.var. *deserti* Zoh.

The *Capparis cartilaginea* Decne and *Capparis spinosa* L.var. *intermis* Turra show a more scattered distribution in Northern Morocco, being present mostly all around Fés city on calcareous cliffs, outcrops and old walls. While in the remainder regions, it is present on cultivated ground and wasteland. The vegetative period is strictly concentrated to spring and summer, coinciding with the life cycle of many xerophilous weeds. The desiccation of leaves accelerates markedly in October and November. We detected differences in both the vegetative and flowering periods

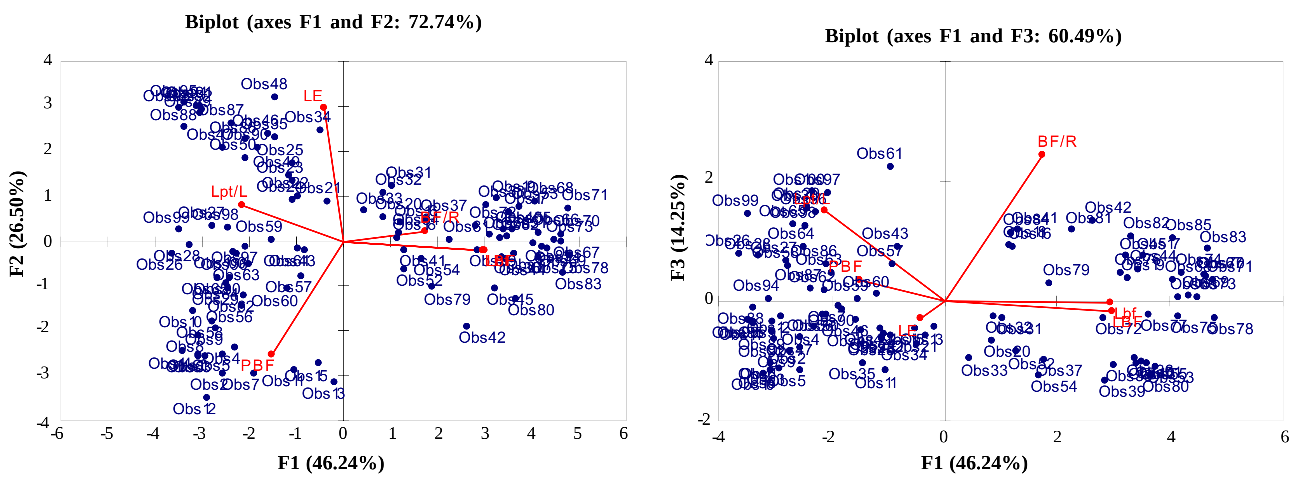

Figure 1. The two scatter plots of PCA (PC 1 = 46.23% of total variability; PC 2 = 26.49% of total variability).

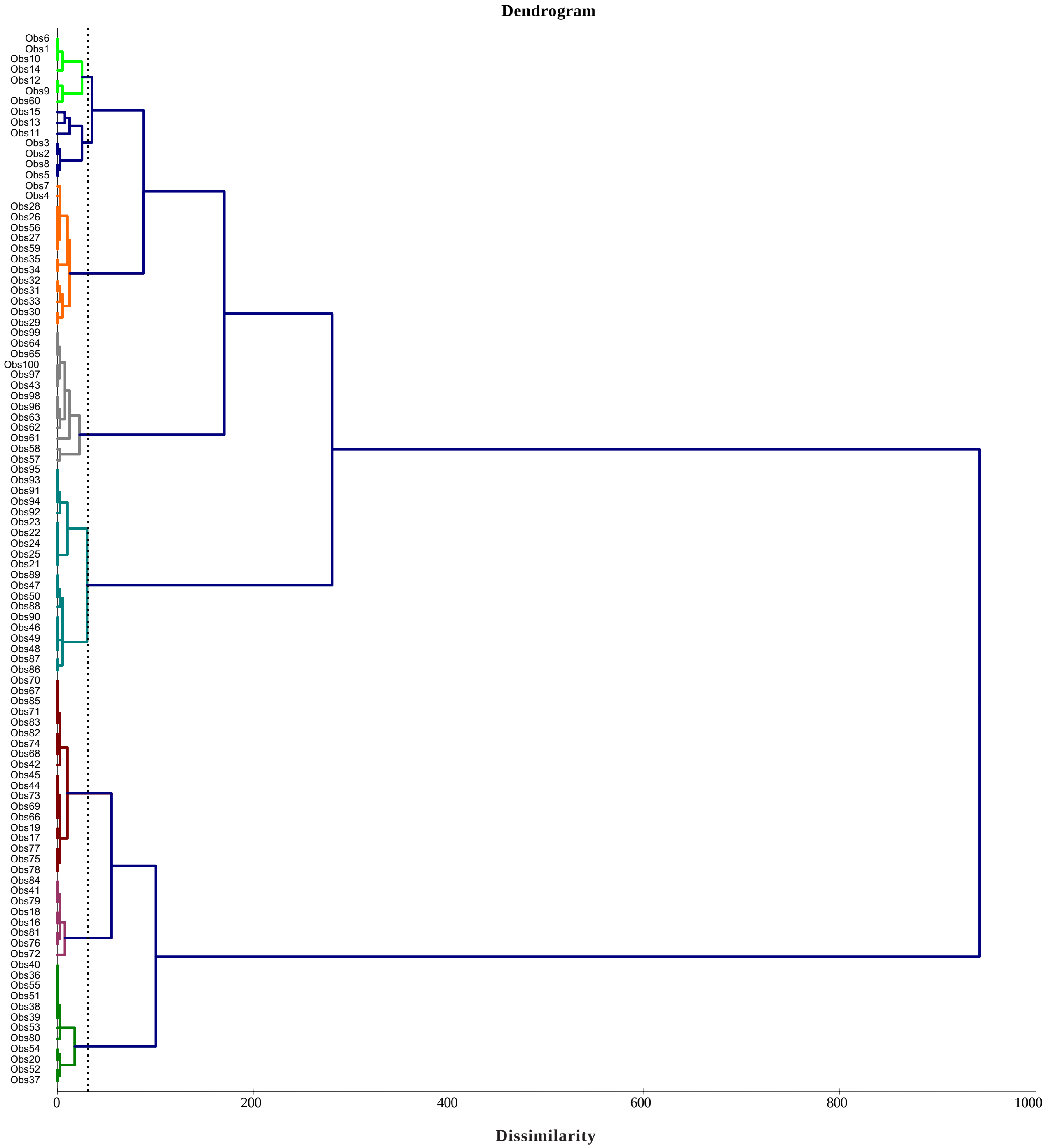

Figure 2. Dendrogram obtained from cluster analysis (Euclidian distances, UPGMA).

Table 4. Qualitative characterization of eight ecotypes from Northern Morocco.

	Apex	CF	FF	CE	CT	FBF	CBF
E1	Aigu/Mucronate	Green+	Round_ovate	Yellow	Green+	cordate	Green
E2	Rond/Mucronate	Green+++	Round	--------	Green++	Cordate	Green++
E3	Mucronate	Green+++	Round	brown	Green++	Cordate	Green++
E4	Mucronate	Green+	Elliptical	brown	Green++	elliptical	Green+++
E5	Mucronate	Green++	Elliptical	brown	Green	elliptical	Green+++
E6	Mucronate	Green+++	Elliptical	brown	Green	elliptical	Green
E7	Mucronate	Green	Round_ovate	brown	Purple/Green	Cordate	Green+++
E8	Mucronate	Green+++	Round_ovate	brown	Purple/Green	Cordate	Green+++

between the *Capparis cartilaginea* Decne and the two species *Capparis ovata* Desf and *Capparis spinosa* L. The timing of various events, e.g. bund-beak and leaf abscission, can be determined by natural selection linked to biotic and abiotic factors [12]. The investigated *Capparis genus* shows an ecological differentiation in other Mediterranean areas, such as in Sicily, where *Capparis spinosa* shows remarkable variability with regard to growth forms and other vegetative characters [7]. According to Fici [7], in typical individuals of *Capparis spinosa*, observed on clay soil, each year from renewal buds at or below ground level, only a few fast-growing, multiramified shoots are produced. In contrast, individuals of the same species growing under atypical pedological conditions (rocky habits) usually show a lignified shoot system like *Capparis spinosa* L.var. *intermis* Turra. In the rocky habitats, the shoot system is less influenced by factors such as fire, competitors and herbivores, which favour its persistence and secondary lignifications.

In Northern Morocco the variability of genus *Capparis* constitutes an edaphic morphocline; currently, the eight extreme forms are treated as different varieties. Following Fici [7], the xeric adaptations of this taxon explains its wide geographical range, including xero-Mediterranean, desertic and temperatexeric areas. Where populations of the three species are present side by side while maintaining different substratum specializations, we must assume that more or less marked barriers restrict gene flow, as Ehrendorfers [13, 14] has stated.

The variation and evolution of three species in Northern Morocco (Region Fés-Taouante-My Idriss): The three species of *Capparis* occurring in Northern Morocco can be classified in two groups: one comprising *Capparis cartilaginea* and *Capparis spinosa* and another including *Capparis ovata*. For the first group, the assumption of Fici [7] "the entities widespread in the Mediterranean originated from a xero-tropical ancestor close to present evergreen shrubs associated with rocky environments, such as *C.cartilaginea*" may be true. The dendrogram (Fig. 2) shows that *Capparis cartilaginea* is close to the variety *Capparis spinosa* var. *inermis* Turra, these are both characteristic of rocky ecotypes in this study.

As a matter of fact, some intermediate characters have been found between the above mentioned varieties and the variety *Capparis spinosa* var. *spinosa*. Following Fici [7] the thorny stipules of *Capparis spinosa* var. *spinosa*, that are always present, can be interpreted as an adaptive feature to the selective pressure of herbivores in lowland environments. The recurved thorny stipules are regarded by Jacobs [3] as derived within the genus *Capparis*.

According to Zohary [2], *Capparis spinosa* var. *aegyptia* is the most primitive form of the group "*Capparis spinosa*, *Capparis sicula*, *Capparis leucophylla*". Following the results of the present analysis the var. *aegyptia* is really close to var. *spinosa* and var. *inermis*. On the other hand, *Capparis spinosa* var. *deserti* is close to all the varieties. Zohary [2] interpreted it as a "weak" variety because small-leaved forms occur almost in all group of *Capparis spinosa*. Perhaps, in our study, this is the reason that the var. *deserti* is not far from the last varieties.

The two taxa known as *C. cartilaginea* and *C. spinosa*, marked by round or round-ovate leaves and their slightly zygomorphy of flower bud (sharp = cordate) (Table 4).

For the second group, in Northern Morocco, the dendrogram (Fig. 2) shows that, *C. ovata* Desf. var. *herbacea* is linked to *C. ovata* Desf. var. *sicula*. In fact, Zohary [2] has seen intermediates between both varieties. This subgroup is close to *C. ovata* Desf. var. *ovata*. According to Zohay [2] *C. sicula*, *C. ovata* and *C. herbacea* have been classified under one species, because they are marked by oblong to elliptical leaves and with their stronger zygomorphy of flower bud (sharp = elliptical) (Table 4).

Conclusions

Field observations and data taken from our collections and literature show the existence of four species in Morocco: *Capparis cartilaginea* Decne, *C. deciduas* (Forsk) Edgew, *C. ovata* Desf and *C. spinosa* L. For the last two species, *C. ovata* Desf is represented by three varieties: *C. ovata* Desf. var. *sicula* (Duham) Zoh, *C. ovata* Desf. var. *herbacea* (Willd) Zoh and *C. ovata* Desf. var. *ovata*. *Capparis spinosa* L. is represented by four varieties: *C. spinosa* L.var. *intermis*. Turra, *C. spinosa* L.var. *spinosa*, *C. spinosa* L.var. *aegyptia* and *C. spinosa* L.var. *deserti* Zoh.

Acknowledgements

This research was supported by the PROFERD Project ENA Meknés Caractérisation morphologique et génétique, et techniques de mise en cultures du câprier au Maroc.

References

[1]Fici, S. and Gianguzzi, L. 1977. Diversity and conservation in wild and cultivated *Capparis* in Sicily. Bocconea **7**:437-443.

[2]Zohary, M. 1960. The species of *Capparis* in the Mediterranean and the Near Eastern countries. Bulletin of the Research Council of Israel **8D**:49-64.

[3]Jacobs, M. 1965. The genus *Capparis* (Capparaceae) from the Indus to the Pacific. Blamea **12**:385-341.

[4]Hington, R. N. and Akeroyd J. R. 1991.Variation in *Capparis spinosa* L. in Europe. Flora Europaea **106**(2):104-112.

[5]Hyeywood, V. H. 1964. *Capparis* L. In Tutin, T. G., Heywood, V. H., Burges, N. A., Valentine, D. H., Walters, S. M. and Webb, D.A. (eds). Flora Europaea 1. Cambridge University Press, Cambridge, 259 p.

[6]Hyeywood, V. H. 1993. *Capparis* L. In Tutin, T. G., Burges, N. A., Chater, A. O., Edmondson, J. R, Heywood, V. H, Moore, D. M., Valentine, D. H., Walters, S. M. and Webb, D. A. (eds). Flora Europaea 1. 2nd edn. Cambridge University Press, Cambridge, 312 p.

[7]Fici, S. 2001. Intraspecific variation and evolutionary trends in *Capparis spinosa* L. (Capparaceae). Plant Syst. and Evol. **228**:123-141.

[8]Fennane, M., Ibn Tattou, M., Mathez, J., Ouyahya, A. and El Oulaidi, J. (eds) 1999. Flore pratique du Maroc. vol. 1 Trav. Inst. Sci. Sér. Bot. 36, Rabat.

[9]Benabid, A. 2000. Flore et écosystèmes du Maroc. Evaluation et préservation de la biodiversité. Ibis Press, Paris, 197 p.

[10]Inocencio, C., Alcaraz, F., Calderon, F., Obon, C. and Rivera D. 2002. The use of floral characters in *Capparis* sect. *Capparis* to determine the botanical and geographical origin of capers. European Food Research and Technology **214**(4):335-339.

[11]Yazough, A. 1997. Le câprier dans la préfecture de Zouagha Moulay Yakoub, Situation actuelle et perspectives de développement. CT de Douiet, 16 p.

[12]Estabrook, G. F., Winsor, J. A., Stephenson, A. G. and Howe, H. F. 1982. When are two phenological pattens different? Bot. Gaz. **143**:374-378.

[13]Ehrendorfer, F. 1970. Evolutionary patterns and strategie in seed plants. Taxon. **19**:185-195.

[14]Ehrendorfer, F. 1968. Geographical and ecological aspects of intraspecific differentiation. In Heywood V. H. (ed.). Modern Methods in Plant Taxonomy. Academic Press, London, pp. 261-296.

Appendix 1: Principal component analysis

Proper values:

	F1	F2	F3	F4	F5	F6
Proper values	2.774	1.590	0.855	0.537	0.213	0.031
Variability (%)	46.237	26.499	14.250	8.945	3.550	0.519
% cumulative count	46.237	72.736	86.986	95.931	99.481	100.000

Correlations between the variables and the factors:

	F1	F2	F3
Lpt/L	-0.675	0.251	0.478
LE	-0.129	0.938	-0.095
LBF	0.947	-0.073	-0.054
Lbf	0.933	-0.066	-0.013
BF/R	0.552	0.070	0.775
PBF	-0.479	-0.796	0.113

Cosine squares of the variables:

	F1	F2	F3
Lpt/L	0.456	0.063	0.229
LE	0.017	0.879	0.009
LBF	0.896	0.005	0.003
Lbf	0.870	0.004	0.000
BF/R	0.305	0.005	0.601
PBF	0.230	0.634	0.013

Simple statistics:

Variable	Observations	Minimum	Maximum	Mean	Standard deviation
Lpt/L	100	0.100	0.300	0.175	0.066
LE	100	1.142	4.030	2.373	0.723
LBF	100	8.060	15.890	12.091	2.261
Lbf	100	9.235	16.980	13.025	2.197
BF/R	100	5.000	14.000	8.838	2.181
PBF	100	0.220	2.820	1.000	0.660

Correlation matrix (Pearson (N):

Variable	Lpt/L	LE	LBF	Lbf	BF/R	PBF
Lpt/L	**1**	**0.272**	**-0.549**	**-0.499**	-0.134	**0.215**
LE	**0.272**	**1**	-0.158	-0.145	-0.078	**-0.590**
LBF	**-0.549**	-0.158	**1**	**0.967**	**0.397**	**-0.350**
Lbf	**-0.499**	-0.145	**0.967**	**1**	**0.408**	**-0.331**
BF/R	-0.134	-0.078	**0.397**	**0.408**	**1**	**-0.256**
PBF	**0.215**	**-0.590**	**-0.350**	**-0.331**	**-0.256**	**1**

The values in hold are significantly different for zero to a signification level alpha = 0.05.

Appendix 2: Analysis of variance

Analysis of variance of the variable (Lpt/L):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	0.408	0.024	69.417	< 0.0001
Error	82	0.028	0.000		
Corrected total	99	0.436			

Computed against model Y= Mean(Y).

Analysis of variance of the variable (LE):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	43.067	2.533	23.787	< 0.0001
Error	82	8.733	0.107		
Corrected total	99	51.800			

Computed against model Y = Mean(Y).

Analysis of variance of the variable (LBF):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	424.259	24.956	25.040	< 0.0001
Error	82	81.725	0.997		
Corrected total	99	505.985			

Computed against model Y = Mean (Y).

Analysis of variance of the variable (Lbf):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	370.643	21.803	16.675	< 0.0001
Error	82	107.215	1.308		
Corrected total	99	477.858			

Computed against model Y=Mean(Y).

Analysis of variance of the variable (BF/R):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	371.164	21.833	17.913	< 0.0001
Error	82	99.946	1.219		
Corrected total	99	471.110			

Computed against model Y = Mean(Y).

Analysis of variance of the variable (PBF):

Source	DDL	Sum of squares	Mean squares	F	Pr > F
Model	17	36.434	2.143	26.421	< 0.0001
Error	82	6.652	0.081		
Corrected total	99	43.086			

Computed against model Y= Mean(Y).