

Seed Characteristics Diversity in Sponge Gourd (*Luffa aegyptiaca* Mill.) Germplasms from Hatay Region in Turkey

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Bulletin UASVM Horticulture 75(1) / 2018

Print ISSN 1843-5262, Electronic ISSN 1843-536X

DOI:10.15835/buasvmcn-hort: 000118

Abstract

The objective of this study was to evaluate seed characteristics of sponge gourd, to establish a core collection of sponge gourd with the germplasm collected throughout the Hatay region. A mini-core collection was assessed for morphological performance and some seed traits. Substantial variations of seed characteristics: seed length, seed width, seed thickness (mm), seed index (length/width), seed size (length × width, mm²), seed colour, seed-coat surface, seed shape, seed wing, and 100-seed weight were investigated. Seed length, width and thickness were varied as 15.12-8.97 mm, 9.71-6.25 mm and 2.86-2.16 mm respectively. The seed sizes were determined from small (31 DÖ 06) to big (31 DE 04). Seed colours were ranged from black to white, even a brown colour like 07 MA 01. A hundred seed weights were observed as 16.43 g (31 AL 02) and 7.41 (31 DÖ 06). The results of dendrogram indicated that seed traits of the sponge gourd genotypes were separating in five groups. This collection of sponge gourds will be useful for the gene pools and a wide range of phenotypic variations to provide a good source of diversity for developing of sponge gourd cultivars in breeding programs.

Keywords: *Luffa cylindrica*, *Luffa acutangula*, seed traits, principal component analysis

Introduction

Vegetable crops, especially the cucurbits (gourds, melons, squashes and pumpkins), are rich sources of nutrients. Sponge gourd is one of the less known in Cucurbits. However, sponge gourd is a popular vegetable in the tropics and is essentially an old-world species. Immature fruits of sponge gourd are used as vegetables and mature fruits as fibres. It is cultivated in Asia and Africa, and widely used as a vegetable in India, China and other Asian countries.

The genus *Luffa* consists of ten species: *Luffa aegyptiaca* Mill., *Luffa acutangula* Roxb., *Luffa graveolens* Roxb., *Luffa echinata* Roxb.,

Luffa umbellata M. Roem., *Luffa tuberosa* Roxb., *Luffa quinquefida* (Hook. & Arn.) Seem., *Luffa astorii* Svens. *Luffa saccata* F.Muell. ex I. Telford. and *Luffa hermofrodita* Singh & Bhandari. *Luffa aegyptiaca* Mill. and *Luffa acutangula* Roxb. are economically cultivated species in the world. *Luffa hermaphrodita* is also cultivated species in minor areas of India (Marr *et al.*, 2005).

Plant genetic resources and germplasms are fundamental sources for plant breeding that the assessment of the genetic diversity among genotypes is useful to facilitate more efficient use of plant genetic resources. Hatay has a rich genetic

Table 1. Some details of sponge gourd genotypes used in this study

No.	Genotype code	Species	Area of collection	Type of cultivation
1	31 AR 01	<i>Luffa aegyptiaca</i>	Arsuz	Ornamental
2	31 AR 02	<i>Luffa aegyptiaca</i>	Arsuz	Ornamental
3	31 AR 03	<i>Luffa aegyptiaca</i>	Arsuz	Ornamental
4	31 AR 04	<i>Luffa aegyptiaca</i>	Arsuz	Ornamental
5	31 AR 05	<i>Luffa aegyptiaca</i>	Arsuz	Ornamental
6	31 DE 01	<i>Luffa aegyptiaca</i>	Defne	Fibres
7	31 DE 02	<i>Luffa aegyptiaca</i>	Defne	Fibres
8	31 DE 03	<i>Luffa aegyptiaca</i>	Defne	Fibres
9	31 DE 04	<i>Luffa aegyptiaca</i>	Defne	Fibres
10	31 DE 05	<i>Luffa aegyptiaca</i>	Defne	Fibres
11	31 DE 06	<i>Luffa aegyptiaca</i>	Defne	Fibres
12	31 DE 07	<i>Luffa aegyptiaca</i>	Defne	Fibres
13	31 SA 01	<i>Luffa aegyptiaca</i>	Samandağ	Ornamental
14	31 AN 01	<i>Luffa aegyptiaca</i>	Antakya	Ornamental
15	31 AN 02	<i>Luffa aegyptiaca</i>	Antakya	Ornamental
16	31 AN 03	<i>Luffa aegyptiaca</i>	Antakya	Ornamental
17	31 AN 04	<i>Luffa aegyptiaca</i>	Antakya	Ornamental
18	31 AN 05	<i>Luffa aegyptiaca</i>	Antakya	Ornamental
19	31 DÖ 01	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
20	31 DÖ 02	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
21	31 DÖ 03	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
22	31 DÖ 04	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
23	31 DÖ 05	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
24	31 DÖ 06	<i>Luffa aegyptiaca</i>	Dörtyol	Ornamental
25	31 YA 01	<i>Luffa aegyptiaca</i>	Yayladağı	Ornamental
26	31 YA 02	<i>Luffa aegyptiaca</i>	Yayladağı	Ornamental
27	31 YA 03	<i>Luffa aegyptiaca</i>	Yayladağı	Ornamental
28	31 YA 04	<i>Luffa aegyptiaca</i>	Yayladağı	Ornamental
29	31 AL 01	<i>Luffa aegyptiaca</i>	Altınözü	Ornamental
30	31 AL 02	<i>Luffa aegyptiaca</i>	Altınözü	Ornamental
31	31 AL 03	<i>Luffa aegyptiaca</i>	Altınözü	Ornamental
32	31 AL 04	<i>Luffa aegyptiaca</i>	Altınözü	Ornamental
33	31 PA 01	<i>Luffa aegyptiaca</i>	Payas	Ornamental
34	31 ER 01	<i>Luffa aegyptiaca</i>	Erzin	Ornamental
35	01 AD 01	<i>Luffa aegyptiaca</i>	Adana	Ornamental
36	07 MA 01	<i>Luffa aegyptiaca</i>	Antalya	Ornamental
37	South Korea	<i>Luffa aegyptiaca</i>	Control	Vegetable
38	China	<i>Luffa acutangula</i>	Control	Vegetable

variability in terms of fruit size and shape and is one of the centres of diversity in Turkey for sponge gourds. Mature fruits of sponge gourd are used fibres for hygienic washer in Hatay. However, no data was found about variability for various traits in germplasm in Turkey. A mini-core collection of sponge gourd germplasm from diverse geographic regions of Hatay was assessed for morphological performance and some seed traits. These genotypes could play a significant role in future breeding programs (Mavi and Gündüz, 2016). In particular, we sought to characterize agronomic, morphological and quality characteristics of the sponge gourd genotypes and to provide

information about diversity in sponge gourd genotypes present for international breeders interested in Turkish sponge gourd genetic resources. The objective of this study was to evaluate the seed characteristics of sponge gourd, to establish a sponge gourd core-collection with the germplasms collected throughout the Hatay region.

Material and methods

A total number of 38 (Collected 36 genotypes from Turkey, and two genotypes from China and South Korea) genotypes were used in this experiment. The seeds of the thirty-six genotypes

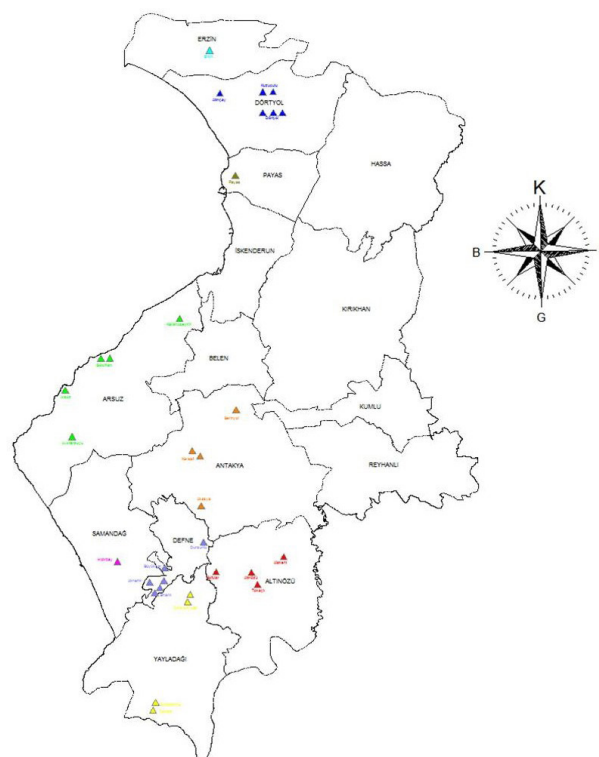


Figure 1. Location of collected genotypes in Hatay province.

were collected from several areas of Hatay province of Turkey. Sources and genotypes were presented in Table 1 and Figure 1.

The variabilities of seed morphological traits [Seed length (mm), seed width (mm), seed thickness (mm), seed index (length/width), seed size (length × width, mm²), seed colour, seed coat surface, seed shape, seed wing and 100 seed weight (g)] were determined in collected genotypes. The morphological study of the seeds was carried out on a sample of 20 seeds per accession and repetition. Seed morphological traits determined according to Heiser and Schilling (1988), and Heneidak and Khalik (2015).

Mean data for each characters were evaluated by one-way analysis of variance (ANOVA) followed by Duncan's multiple range test when the P value less than 0.05 was considered significant. Principal component (PC) and cluster analysis were carried out using the PRINCOMP procedure and UPGMA method (Unweighted Pair-group Method, Arithmetic Average) respectively. Data processing was performed using the NTSYS (Numerical Taxonomy System) program.

Results and discussions

The seed morphological characters for studied genotypes of the genus *Luffa* are summarized in Table 2 and 3. The morphological characters of seeds showed wide variation. The range of variation for seed weight, width and length was very large. While the seed width was ranged from 9.71 mm (31 DE 03) to 6.25 mm (31 DÖ 06), the seed length was changed from 15.12 mm (31 DE 04) to 8.97 mm (31 DÖ 06). The highest seeds thickness (2.86 mm) was measured in 31 DÖ 01, but the smallest thickness (2.16 mm) was measured in 31 DÖ 03. Similarly, seed size and seed index were varied among the selected genotypes of *Luffa*.

The seed weight was ranged from 7.3 g (31 DÖ 06) to 16.4 g (31 AL 02). Other genotypes were determined between these values. Seed colour of genotypes varied from black to white. The seed surface ranged from smooth to scaly. While of genotypes have a smooth surface, some of them (31 DE 02, 31 DÖ 02 and China) have a wrinkled, creased and scaly. Seed shape in the genotypes categorized by ovoid, elongate ovoid and elongate. 31 DÖ 03 has a very conspicuous seed wing, but the genotype of China (*L. acutangula*) lack of the seed wing (Table 3 and Figure 2).

Table 2. Some seed morphological characters at genotypes of *Luffa*

Genotype code	Seed length (mm)	Seed width (mm)	Seed thickness (mm)	Seed size (mm ²)	Seed index L/W
31 AR 01	13.57 de	8.40 fghij	2.49 lmno	114	1.62
31 AR 02	11.85 stu	8.36 fghij	2.54 hijklm	99	1.42
31 AR 03	12.35 mnop	8.93 c	2.71 cdef	110	1.38
31 AR 04	11.45 v	7.75 mno	2.68 defg	89	1.48
31 AR 05	12.42 mno	7.75 mno	2.70 cdef	96	1.60
31 DE 01	11.98 prst	7.85 lmn	2.61 efghij	94	1.53
31 DE 02	11.92 rst	8.39 fghij	2.70 cdef	100	1.42
31 DE 03	13.94 c	9.71 a	2.48 lmno	135	1.44
31 DE 04	15.12 a	9.47 ab	2.31 rs	143	1.60
31 DE 05	11.86 stu	7.74 no	2.68 defg	92	1.53
31 DE 06	11.49 uv	7.93 klmn	2.40 oprs	91	1.45
31 DE 07	12.70 ijklm	8.81 cd	2.29 s	112	1.44
31 SA 01	13.45 def	8.55 defg	2.73 bcd	115	1.57
31 AN 01	13.15 fgh	8.65 cdef	2.51 jklmn	114	1.52
31 AN 02	12.52 lmn	8.53 defgh	2.48 lmno	107	1.47
31 AN 03	11.80 stuv	7.61 no	2.75 bcd	90	1.55
31 AN 04	13.40 defg	8.70 cdef	2.50 klmn	117	1.54
31 AN 05	12.48 mn	8.42 fghi	2.34 rs	105	1.48
31 DÖ 01	13.21 efgh	7.47 op	2.86 a	99	1.77
31 DÖ 02	13.49 def	9.57 a	2.82 ab	129	1.41
31 DÖ 03	13.59 d	8.78 cde	2.16 t	119	1.55
31 DÖ 04	13.22 defgh	8.65 cdef	2.80 abc	114	1.53
31 DÖ 05	12.94 hij	8.28 ghij	2.73 bcd	107	1.56
31 DÖ 06	8.97 y	6.25 r	2.53 hijklm	56	1.44
31 YA 01	12.02 prst	7.89 klmn	2.46 mnopr	94	1.52
31 YA 02	12.06 oprs	8.49 defgh	2.62 efghi	102	1.42
31 YA 03	11.90 rst	7.83 lmn	2.42 noprs	93	1.52
31 YA 04	11.79 stuv	7.93 klmn	2.31 rs	94	1.49
31 AL 01	12.87 hijkl	8.10 ijkl	2.64 defgh	104	1.59
31 AL 02	14.32 b	8.47 efgh	2.61 efghij	121	1.69
31 AL 03	12.90 hijk	8.20 hijk	2.58 ghijkl	106	1.57
31 AL 04	12.53 klmn	7.65 no	2.42 noprs	96	1.64
31 PA 01	11.98 prst	7.68 no	2.35 prs	92	1.56
31 ER 01	12.26 nopr	8.59 defg	2.72 bcde	105	1.43
01 AD 01	13.05 ghi	9.27 b	2.52 ijklmn	121	1.41
07 MA 01	12.27 nopr	8.08 jklm	2.37 oprs	99	1.52
South Korea	11.65 tuv	7.21 p	2.82 ab	84	1.62
China	12.63 jklmn	7.77 lmno	2.47 lmnop	98	1.63

The seeds of the genotypes of *Luffa* under investigation varied in size, shape and colour. Prakash *et al.* (2014) determined the genotypes of the *L. aegyptiaca* group, variability in 100-seed weight (6.58–18.58 g), length (10.0–14.0 mm), and width (5.6–9.8 mm). Our results about 100 seed weight, seed length and width are similar to the result of Prakash *et al.* (2014). Heneidak and Khalik (2015) presented seed colour varied from black in *Luffa acutangula* and black to brown in *L. aegyptiaca*. But it can be white colour. Present study showed white coloured genotypes (Figure 2).

The result of principle component analysis showed that there was variation among the genotypes depending on the seed morphological characters. The first four PCs gave Eigen values greater than 1.0 and explained 83.7% of the total variation, with 38.1, 21.6, 14.0 and 10.0%, respectively. We considered as values above 0.47 to be significant for important parameters. The important variables composed in PC1 were: SL, SW, SS, SWe, and Su. While SW, SI and SSh were the most important variables in PC2, ST, SC, Su and Swi were the most important variables for PC3 (Table 4).

Table 3. Some seed morphological characters at genotypes of *Luffa*

Genotype code	Seed weight (g)	Seed color	Surface	Seed shape	Seed wing
31 AR 01	15.0 bc	Black	Smooth	Elongate ovoid	Indistinct
31 AR 02	12.3 kl	Black	Smooth	Ovoid	Present
31 AR 03	13.4 gh	Black	Smooth	Ovoid	Present
31 AR 04	9.5 s	Black	Smooth	Ovoid	Present
31 AR 05	13.2 ghi	Black	Smooth	Elongate ovoid	Present
31 DE 01	11.6 n	Black	Smooth	Ovoid	Present
31 DE 02	10.8 p	Black	Smooth	Ovoid	Indistinct
31 DE 03	15.1 bc	Black	Wrinkled	Ovoid	Present
31 DE 04	14.5 cd	Brown	Wrinkled	Elongate ovoid	Indistinct
31 DE 05	10.4 pr	Black	Smooth	Ovoid	Present
31 DE 06	10.1 r	Black	Smooth	Ovoid	Indistinct
31 DE 07	11.7 mn	Black	Smooth	Ovoid	Present
31 SA 01	14.7 bc	Black	Smooth	Elongate ovoid	Present
31 AN 01	13.9 ef	Black	Wrinkled	Ovoid	Present
31 AN 02	11.6 n	Black	Smooth	Ovoid	Present
31 AN 03	8.4 k	Black	Smooth	Elongate ovoid	Present
31 AN 04	14.3 de	Black	Smooth	Ovoid	Present
31 AN 05	12.7 ijk	Black	Smooth	Ovoid	Indistinct
31 DÖ 01	13.9 ef	Black	Smooth	Elongate	Indistinct
31 DÖ 02	15.4 b	White	Creased	Ovoid	Present
31 DÖ 03	12.5 jkl	Black	Smooth	Elongate ovoid	Present
31 DÖ 04	15.7 ab	Black	Smooth	Ovoid	Present
31 DÖ 05	14.7 bcd	Black	Smooth	Elongate ovoid	Present
31 DÖ 06	7.3 u	Black	Smooth	Ovoid	Present
31 YA 01	10.6 pr	Black	Smooth	Ovoid	Present
31 YA 02	13.5 fg	Gray	Smooth	Ovoid	Present
31 YA 03	11.4 no	Black	Smooth	Ovoid	Present
31 YA 04	10.5 pr	Black	Smooth	Ovoid	Present
31 AL 01	11.7 mn	Black	Smooth	Elongate ovoid	Present
31 AL 02	16.4 a	Black	Smooth	Elongate	Present
31 AL 03	12.1 lm	Black	Wrinkled	Elongate ovoid	Present
31 AL 04	12.5 jkl	White	Smooth	Elongate ovoid	Present
31 PA 01	9.4 s	Black	Smooth	Elongate ovoid	Present
31 ER 01	12.9 hij	Black	Smooth	Ovoid	Present
01 AD 01	14.7 bcd	Black	Smooth	Ovoid	Present
07 MA 01	10.9 op	Brown	Smooth	Ovoid	Present
South Korea	9.4 s	Black	Smooth	Elongate ovoid	Present
China	15.0 bc	Dark Black	Scaly	Elongate ovoid	Absent

The UPGMA dendrogram obtained with 10 seed morphological traits for the 38 sponge gourd genotypes, were given in Figure 1. The accessions were clustered into five main groups. Group 1 consisted of 23 accessions showed very similar seed characters. The genotype of South Korea and 31DÖ06 were classified alone in group III and group V.

Similar results were reported in genotypes of *Luffa hermaphrodita* (Choudhary *et al.*, 2009), *Luffa acutangula* (Heiser and Schilling 1988; Marr *et al.*, 2005; Choudhary *et al.*, 2011), *Luffa aegyptiaca* (Heiser and Schilling 1988; Marr *et*

al., 2005), used morphological markers like a seed weight, seed length, seed width, seed colour for assessment of relationships and estimating genetic diversity.

Conclusions

Characterization and conservation of crop genetic resources are major components in breeding improvement programs, especially with unattended and minor vegetable crops. The present study showed the existence of considerable genetic variability amongst Turkey sponge gourd genotypes. The availability of sponge



Figure 2. Variation for seed morphology among 36 sponge gourd landrace collections from Hatay province of Turkey and two control genotypes in South Korea and China (*Luffa acutangula*). Seeds of different genotypes are not represented at the same scale; the size of the grid cells is 1 × 1 cm.

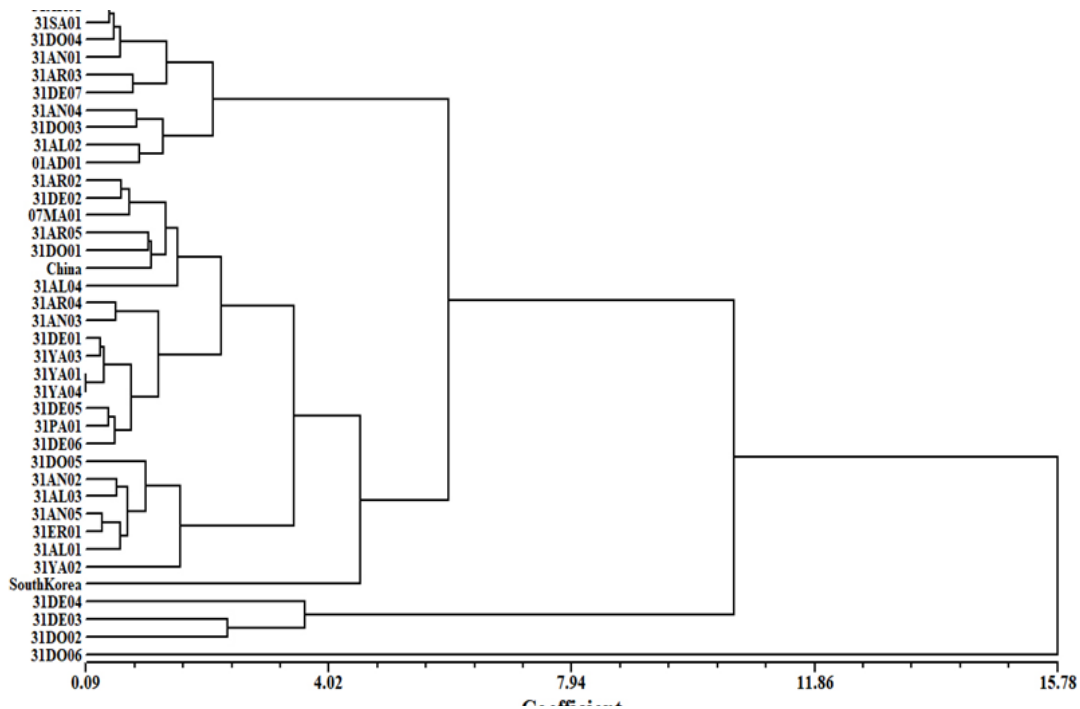


Figure 3. UPGMA dendrogram based on seed morphological characters distances 36 sponge gourd landrace collections from the Hatay province of Turkey and two control genotypes in South Korea and China (*Luffa acutangula*).

Table 4. Eigen values and cumulative variance of the first four-principle component (PC) analysis for some seed morphological characters at genotypes of *Luffa*

Principal component	PC1	PC2	PC3	PC4
Eigen value	3.8	2.2	1.4	1.0
Variance (%)	38.1	21.6	14.0	10.0
Cumulative variance (%)	38.1	59.7	73.7	83.7
Characters				
Seed length (SL, mm)	0.48	-0.15	-0.14	-0.02
Seed width (SW, mm)	0.44	0.29	-0.17	0.11
Seed thickness (ST, mm)	-0.02	-0.17	0.30	0.81
Seed size (SS, mm ²)	0.49	0.08	-0.16	0.03
Seed index (SI, L/W)	0.07	-0.64	0.06	-0.17
Seed weight (SWe, g)	0.45	-0.07	0.03	0.22
Seed color (SC)	0.17	0.11	0.49	-0.47
Surface (Su)	0.27	0.14	0.53	-0.11
Seed shape (SSh)	-0.11	0.63	-0.06	0.09
Seed wing (SWi)	0.04	-0.09	-0.55	-0.14

sourd diversity is useful for sponge gourd cultivar improvement in Turkey. In addition, fat and protein content of seeds should be investigated in terms of consummability.

Acknowledgments: This research was supported by TÜBİTAK (Project number 116 O 127).

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