

DIFFERENTIATION BETWEEN SOME TAXA OF *Brassica* SIMILAR IN SEED SHAPE AND PLANT ORGANS AT EARLY GROWTH STAGES

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ABSTRACT

This investigation was carried out at the greenhouse of the Department of Agricultural Botany, Faculty of Agriculture, Cairo University, during 2006 season to differentiate between three taxa of *Brassica*; namely, *B. oleracea* var. *botrytis* (Cauliflower), *B. oleracea* var. *italica* (Broccoli) and *B. oleracea* var. *capitata* (Cabbage), being similar at early stages of growth as well as seed shape.

The results showed that, there were clear differences between the three taxa as some macro- and micro-morphological characters were used such as; seed colour (light brown to dark grey in Cauliflower, red to light red in Broccoli, and light brown to light grey in Cabbage), hilum colour (dark grey in Cauliflower, light brown in Broccoli, and light grey in Cabbage), seed surface sculpture by using SEM (ruminant-pusticulate in Cauliflower, ruminant with weak reticulate in Broccoli, and reticulate-rugose in Cabbage), leaf lamina margin (crenatus in Cauliflower, erosus in Broccoli, and serratus in Cabbage), leaf lamina base (inaequilaterus in Cauliflower, truncates in Broccoli and breve angustatus in Cabbage).

Meanwhile, the anatomical differences of leaf lamina, petiole, stem and root were less clear between the three investigated taxa at the early stages of growth (up to 45 days). Thus, the anatomical studies may be more useful at older plant stages to find out these differences.

Key words: *anatomy, brassica, broccoli, cabbage, cauliflower, morphology, seed, seedling, SEM.*

1. INTRODUCTION

The genus *Brassica* belongs to the family Brassicaceae (Cruciferae) which is commonly known as the mustard family. The family consists of about 375 genera and 3200 species, and includes crops, condiments, ornamentals, and many weeds. *Brassica* contains about 100 species, including cabbage, cauliflower, broccoli, brussels sprouts, various mustards and weeds (Willis, 1973).

Brassicaceae plants are found mainly in the North Temperate zone, particularly in the Mediterranean region. Plants are annual, biennial or perennial, herbs or very seldom shrubs. The family plants are rich in vitamin C, and sulphur compounds which give their pungent odour. Vegetables; such as broccoli and cauliflower are known to be anticancer foods (Cronquist, 1981, and Jones and Luchsinger, 1987). *Brassica* species have a great economic significance in agriculture as

oilseed, now being the world's third most important source (Downey,1990, and Kumar,1995).

There are six genetically related species, *B. nigra*, *B. rapa*, *B. napus*, *B. carinata*, *B. juncea*, and *B. oleracea*, which includes; *B. oleracea* var. *capitata* L.(Cabbage), *B. oleracea* var. *botrytis* L.(Cauliflower) and *B. oleracea* var. *italica* L.(Broccoli) (Robbelen *et al.*,1989).

The morphology of seed surface has been the subject of many studies. Karcz *et al.* (2005) investigated the morphology of seed surfaces by using SEM and found that, the seed coat varied in shape and size of the epidermal cells of the testa and also the structure of the outer periclinal and anticlinal cell walls.

Other recent studies of different seed coat characters employed SEM. Koul *et al.*, (2000), gave detailed descriptions of seed

morphology in 44 species of the Brassicaceae, Raphaninae and Moricandiinae, and elucidated the phylogenetic relationships between them. Recently, Zeng *et al.* (2004) examined testa topographic patterns during seed development in the cultivated forms of these species. Vaughan and Whitehouse (1971) studied the macro- and micro-morphological characters of approximately 90 genera and 200 species of Brassicaceae with special interest in the relationship between structure and existing taxonomy. Tantawy *et al.* (2004) investigated the seed exomorphic characters of 34 taxa of Brassicaceae representing 22 genera and 30 species by using LM and SEM. They concluded that the seed exomorphic characters, are diagnostic at the genetic and specific level; seed shape, dimensions, colour of epidermal cells, seed surface sculpture and aspects of anticlinal and periclinal walls.

The present study was conducted to differentiate between three taxa of *Brassica* being similar at early stages of growth as well as their seed shape.

2. MATERIALS AND METHODS

The present research was carried out at the greenhouse of the Department of Agricultural Botany, Faculty of Agriculture, Cairo University, to differentiate between three taxa belonging to the genus *Brassica* of Brassicaceae ; *B. oleracea* var. *capitata* L.(Cabbage), *B. oleracea* var. *botrytis* L.(Cauliflower) and *B. oleracea* var. *italica* L.(Broccoli). Seeds of the three taxa were obtained from the Department of Vegetable Researchs, Agricultural Research Center, Dokki, Giza, Egypt.

Pots, 30 cm in diameter were filled with sand and peatmoss, at the rate of 1:3. Five seeds/pot were sown on 15 October 2006 and 5 pots/species were assigned for the study of the following characters:

- 1) Description of the morphology of the first vegetative leaf (30 day old).
- 2) Anatomical studies: a) Samples 1cm long, were taken from the middle portion of the tap root at the age of 10 days to get intact roots and the apical internodes at the age of 30 days. b) Petiole and lamina at the two ages of 30 and 45 days.

All anatomical specimens were killed and fixed in F.A.A.(10ml Formalin-5ml Acetic acid-85ml Alcohol70%), washed in 50% ethyl

alcohol, dehydrated in normal butyl alcohol series and embedded in paraffin wax (55°C mp.), (Sass, 1958). Cross sections 20 µm thick, were cut, using rotary microtome , stained by crystal violet /erythrosin combination and mounted in Canada balsam (Jackson, 1926). Sections were examined and counts and measurements of different tissues were calculated. Photomicrographs were also taken.

Mature seeds of the studied taxa were used for SEM examination, at various magnifications to elucidate seed morphological features. Magnification power ranged between X25 to X1300, depending on size of the seeds to show the finest details of seed surface sculptures. Terms given by Murley (1951) and modified by Stearn (1983) were used.

Seed dimensions were measured by using a micrometer eyepiece, and averages of 10 readings for seed length and width were calculated. Morphological features of different seeds were described using a binocular stereomicroscope.

The detailed surface scan features were examined using a JEOL-JSM-T 100 Model Scanning Electron Microscope and SEM-micrographs were taken at the Central Laboratory, National Research Center (NRC), Dokki, Giza, Egypt.

3. RESULTS AND DISCUSSION

3.1. Plant Morphology

3.1.1. Morphology of lamina and seed:

Shape and morphology characters of leaf lamina, seed and seed measurements of the three studied taxa are presented in Table (1) and Figs. (1 and 2).

The lamina shape is ovatum in cauliflower, obtuse crenatum in broccoli and oval in cabbage. On the other hand, leaf margin is crenatous , erosus and serratus, for cauliflower, broccoli and cabbage plants; respectively. For the lamina tip and base, it was obtusus and inaequilaterus, in cauliflower; round and truncatus in broccoli; and obtuse and breve angustatus in cabbage.

Concerning seed characters and measurements, the colours of the seeds are light brown to dark grey, for cauliflower; red to light red, for broccoli; and light brown to light grey in cabbage. Averages of measurements of seed length and width are 1.9 and 1.7mm, 1.9 and 1.7mm; and 2.0

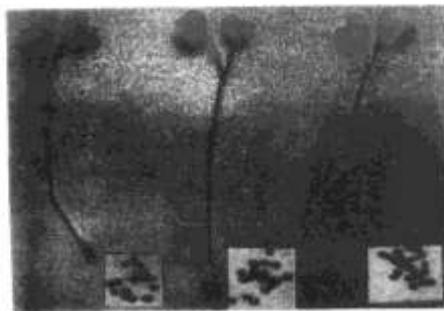


Fig. (1): A photograph of 10 days old seedlings showing similarity of *Brassica oleracea* var. botrytis (A) (Cauliflower), *B. oleracea* var. italica (B) (Broccoli) and *B. oleracea* var. capitata (C) (Cabbage) and shape of the mature seeds in the same order.

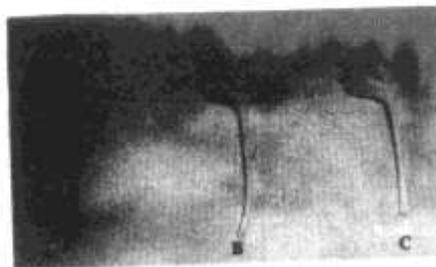


Fig. (2): A photograph of the first leaf (10 days old) showing differences of *Brassica oleracea* var. botrytis (A) (Cauliflower), *B. oleracea* var. italica (B) (Broccoli) and *B. oleracea* var. capitata (C) (Cabbage).

and 7mm in cauliflower, broccoli and cabbage respectively, while length X width (LXW) of the three taxa are 3.2, 3.2 and 3.4 mm² in the same order. Hilum shape is similar in the three taxa, while its colours are dark grey in cauliflower, light brown in broccoli, and light grey in cabbage seeds.

3.2. Plant anatomy

3.2.1. The leaf lamina

Lamina anatomical features of the three studied taxa in 30 and 45 days old plants are presented in Tables 2 and 3 and Figs.3 and 4 (A, B and C).

3.2.1.1. Cauliflower

At the age of 30 days, the upper surface in the midrib region (Fig., 3A) is concave, while the lower one is convex, and the thickness of the upper and the lower epidermis recorded 15.5 and 12.4 μm , respectively (Table, 2). The mesophyll tissue (234.6 μm thick) consists of 2-3 layers of palisade tissue (129.8 μm thick). The spongy tissue (103.8 μm thick) is composed of 4-5 layers of chlorenchymatous cells, loosely arranged with many wide intercellular spaces. The lamina thickness averages 263.6 μm , while at midrib region it is about 558.2 μm , the midrib bundle is slightly rounded in shape with a length and width of 129.8 and 103.8 μm , respectively.

The lamina in 45 day old plants (Table, 3 and Fig., 4A) recorded 432.5 μm in thickness, and its upper and lower epidermis are 41.5 and 28.4 μm , respectively. The mesophyll tissue (348.2 μm thick) consists of 2-3 layers of palisade tissue (178.4 μm thick) and 4-5 layers of spongy tissue (169.8 μm thick). Thickness of midrib region is 428.7 μm and its bundle averages 122.4 and 94.3 μm in length and width, respectively.

3.2.1.2. Broccoli

The lamina thickness at 30 day old averages 196.7 μm and the upper and the lower epidermal layers are 9.3 and 15.5 μm , thick, respectively. The mesophyll tissue averages 168.7 μm in thickness and consists of 2-3 layers of palisade tissue averages (90.9 μm thick) underlying the upper epidermis, and 4-5 layers of spongy tissue (77.9 μm thick), loosely arranged with many wide intercellular spaces. At the midrib region (about 636.4 μm thick), both upper and lower surfaces are convex. The midrib bundle is nearly square in shape and with a length and width of 129.8 and 142.8 μm ; respectively (Table, 2 and Fig., 3B).

At the age of 45 days (Table, 3 and Fig., 4B), the lamina thickness averages 428.7 μm and its upper and lower epidermis thickness are 38.5 and 24.2 μm , respectively. The mesophyll tissue thickness is 374.8 μm and consists of 2-3 layers of palisade cells (216.5 μm thick) and 4-5 layers of spongy cells (157.2 μm thick). The midrib region recorded 412.5 μm in thickness with midrib bundle, being 92.4 and 74.5 μm in length and width, respectively.

Table (1): Morphological descriptions of the leaf and seed of the three studied taxa; Cauliflower, Broccoli and Cabbage.

Taxa	Cauliflower	Broccoli	Cabbage
Characters			
Leaf lamina: Shape	ovatum	obtuse crenatum	oval
Margin	crenatus	erosus	serratus
Tip	obtusus	round	obtuse
Base	inaequilaterus	truncates	breve angustatus
Seed: Colour	light brown to dark grey	red to light red	light brown to light grey
Length (L) mm	1.9	1.9	2.0
Width (W) mm	1.7	1.7	1.7
L X W mm ²	3.2	3.2	3.4
Hilum: Shape	semi-lunar	semi-lunar	semi-lunar
Colour	dark grey	light brown	light grey

Table (2): Measurements of certain microscopical features in transverse sections of lamina of 30 day old plants of the three studied taxa; Cauliflower, Broccoli and Cabbage (Averages of 10 readings).

Taxa	Cauliflower	Broccoli	Cabbage
Characters			
Upper epidermis thickness (µm)	15.5	9.3	24.8
Lower epidermis thickness (µm)	12.4	15.5	15.5
Lamina thickness (µm)	263.6	196.7	273.8
Mesophyll thickness (µm)	234.6	168.7	233.8
Palisade tissue thickness (µm)	129.8	90.9	129.8
No. of palisade layers	2-3	2-3	2-3
Spongy tissue thickness (µm)	103.8	77.9	103.8
No. of spongy layers	4-5	4-5	4-5
Thickness of midrib region (µm)	558.2	363.4	610.1
Length of midrib bundle (µm)	129.8	129.8	142.8
Width of midrib bundle (µm)	103.8	142.8	220.7

Table (3): Measurements of certain microscopical features in transverse sections of lamina of 45 day old plants of the three studied taxa; Cauliflower, Broccoli and Cabbage (Averages of 10 readings).

Taxa	Cauliflower	Broccoli	Cabbage
Characters			
Upper epidermis thickness (µm)	41.5	38.5	42.2
Lower epidermis thickness (µm)	28.4	24.2	36.5
Lamina thickness (µm)	432.5	428.7	464.3
Mesophyll thickness (µm)	348.2	374.8	378.6
Palisade tissue thickness (µm)	178.4	216.5	190.8
No. of palisade layers	2-3	2-3	2-3
Spongy tissue thickness (µm)	161.6	157.2	176.4
No. of spongy layers	4-5	4-5	4-5
Thickness of midrib region (µm)	428.7	442.5	432.5
Length of midrib bundle (µm)	122.4	92.4	88.5
Width of midrib bundle (µm)	94.3	74.5	68.7

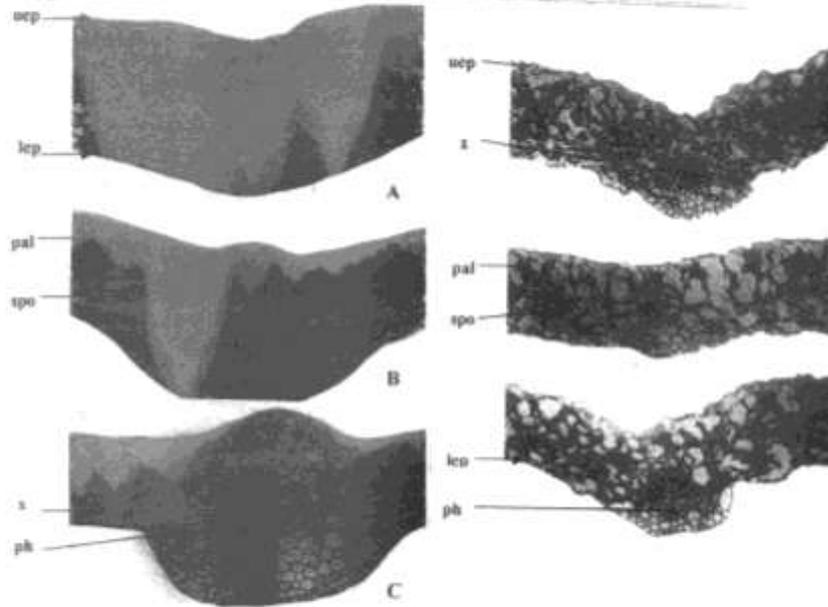


Fig. 13b. Transverse sections of leaf lamina crossing the midrib of 30 days-old plants of *Brassica cauliflora* var. *botrytis* (A), *B. cauliflora* var. *botrytis* (B) (broccoli) and *B. cauliflora* var. *capitata* (C) (Cabbage). Details: lep, lower epidermis; pal, palisade tissue; ph, phloem; spo, spongy tissue; nep, upper epidermis. \times 500 (A, B, C).

Fig. 14b. Transverse sections of leaf lamina crossing the midrib of 30 days-old plants of *Brassica cauliflora* var. *botrytis* (A), *B. cauliflora* var. *botrytis* (B) (broccoli) and *B. cauliflora* var. *capitata* (C) (Cabbage). Details: lep, lower epidermis; pal, palisade tissue; ph, phloem; spo, spongy tissue; nep, upper epidermis. \times 500 (A, B, C).

3.2.1.3. Cabbage

The blade of the first leaf at the age of 30 days (Table 2 and Fig. 3C) is 273.8 μ m in thickness. The adaxial and abaxial epidermal layers are 14.8 μ m and 15.5 μ m thick, respectively. The mesophyll thickness is 233.8 μ m and consists of 2-3 layers of palisade cells (129.2 μ m thick) and a spongy tissue of 4-5 layers (103.8 μ m thick) of chlorenchymatous loosely arranged cells. The midrib region averages 630.1 μ m with a vascular bundle rectangular in shape, being 142.8 μ m in length and 220.7 μ m in width. The blade of the first leaf at the age of 45 days (Table 3 and Fig. 4C) recorded 461.2

μ m thick, and the upper and the lower epidermal cells are 42.2 and 36.5 μ m thick. The mesophyll thickness is 378.6 μ m and composed of palisade cells (2-3 layers) and spongy cells (4-5 layers), being 190.8 and 176.4 μ m thick, respectively. The midrib region averages 432.5 μ m and its bundle is 88.5 μ m in length and 68.7 μ m in width.

3.2.2. The leaf petiole

The upper surface in the three plants is concave with various degrees giving a kidney shape. Petiole anatomical features of the studied taxa are presented in Tables (4 and 5) and Figs. 5 and 6 (A, B and C).

3.2.2.1. Cauliflower

In 30 day old plants, the petiole is crescent-

shaped 780.0 μm long and 1363.0 μm in width (Table, 4 and Fig. 5A), with upper epidermis, 15.5 μm thick, and a lower epidermis 9.3 μm thick, respectively. There are 3 large vascular bundles in the middle embedded in parenchyma, and the largest measured 162.3 and 227.5 μm in length and width, respectively.

At the age of 45 days, (Table, 5 and Fig., 6A) the petiole of the first leaf recorded 694.8 μm in length and 487.3 μm in width. The upper and the lower epidermis are 33.2 and 27.4 μm thick, respectively. There are 3 vascular bundles. Length and width of the largest medium bundle are 177.4 and 218.5 μm , respectively.

3.2.2.2 Broccoli

At the age of 30 days, Broccoli petiole is almost crescent shaped in transverse section (Fig., 5B), with dimensions of 584.1 μm in length and 1168.2 μm in width (Table, 4). The upper epidermis is 21.7 μm thick, while the lower one is 18.9 μm . Three vascular bundles are embedded in parenchymatous tissue. Length and width of the largest median bundle are 155.8 and 220.7 μm , respectively.

On the other hand, the petiole at the age of 45 days (Table, 5 and Fig., 6B) recorded 1224.6 μm in length and 658.4 μm in width. The upper and the lower epidermal cells are 35.5 and 28.4 μm . The vascular tissue consists of 3 bundles. The largest median bundle recorded 175.2 and 266.5 μm in length and width, respectively.

3.2.2.3 Cabbage

The petiole of the first leaf, at the age of 30 days is almost kidney shaped (Fig., 5C), with a length and width of 877.5 and 1300.0 μm , respectively. It has three vascular bundles embedded in the ground tissue. Dimensions of the largest median bundle are 162.5 μm in length and 260.0 μm in width (Table, 4).

The recorded measurements of the petiole at the age of 45 days are 912.7 and 574.2 μm in length and width, respectively (Table, 5 and Fig., 6C). The upper and lower epidermis average 29.2 and 31.4 μm , respectively. There are 3 vascular bundles in the petiole. Length and width of the largest median bundle are 218.2 and 274.5 μm , respectively.

3.2.3 The stem

Stem anatomical structures of the three studied taxa are presented in Table 6 and Fig. 7.

3.2.3.1 Cauliflower

The stem is ovate in shape (Fig. 7A), 1293.4 μm in diameter. Epidermis thickness is 15.5 μm . The cortex averages 220.7 μm and consists of 7-9 layers. The stele consists of conjugated vascular bundles arranged in one ring. Vascular cylinder averages 129.8 μm in thickness. Two major cortical bundles are located outside the vascular cylinder. The pith consists of round parenchyma cells 558.1 μm in diameter and intercellular spaces of different sizes.

3.2.3.2 Broccoli

Stem in cross section is round, averaging 1022.1 μm in diameter, while the pith diameter is 415.4 μm (Fig., 7B). The epidermis averages 17.1 μm , while cortex thickness is 155.8 μm , and consists of 6-8 layers. The vascular cylinder is 129.8 μm thick, and consists of one ring of continuous bundles.

3.2.3.3 Cabbage

Cabbage stem is also round in outline, with diameter averages 1141.8 μm . Thickness of epidermis is 18.6 μm , while cortex (9-11 layers of parenchyma) is 155.8 μm thick. Vascular cylinder averages 103.8 μm in diameter and consists of one ring of correlated bundles. Pith diameter averages 584.1 μm , (Fig., 7C).

3.2.4 The root

Root anatomical features of the 10 day old seedlings of the three studied taxa are presented in Table (7) and Fig. 8 (A, B and C).

3.2.4.1 Cauliflower

Structure of the main root as in (Fig., 8A); indicates irregular outline, with a diameter 312.2 μm . The epidermis thickness is 12.4 μm and is ruptured in many parts due to the early start of secondary growth. The cortex is 90.9 μm thick with 3-4 layers. Vascular cylinder is 103.8 μm in diameter. Number of primary xylem arms is four. At this age (10 days), there is no pith as the metaxylem occupies the center of the cross section, where the secondary growth starts early.

3.2.4.2 Broccoli

The root is slightly round in outline and its diameter is 452.3 μm (Fig., 8B). The epidermis is 15.5 μm thick and is ruptured in many parts. Thickness of cortex is 142.8 μm , with 4-5 layers. Diameter of vascular cylinder is 129.8 μm . The primary xylem consists of

Table (4): Measurements of certain microscopical features in transverse sections of leaf petiole of 30 day old plant of the three studied taxa: Cauliflower, Broccoli and Cabbage. (Averages of 10 readings).

Characters	Taxa	Cauliflower	Broccoli	Cabbage
Upper epidermis thickness (μm)		15.5	21.7	21.7
Lower epidermis thickness (μm)		9.3	18.9	15.5
Dimensions of the petiole (μm):				
	Length (μm)	780.0	584.1	877.5
	Width (μm)	1365.0	1168.2	1300.0
No. of vascular bundles		3.0	3.0	3.0
Length of median bundle (μm)		162.5	155.8	162.5
Width of median bundle (μm)		227.5	220.7	260.0

Table (5): Measurements of certain microscopical features in transverse sections of leaf petiole of 45 day old plants of the three studied taxa; Cauliflower, Broccoli and cabbage. (Averages of 10 readings).

Characters	Taxa	Cauliflower	Broccoli	Cabbage
Upper epidermis thickness (μm)		33.2	35.5	29.2
Lower epidermis thickness (μm)		27.4	28.4	31.4
Dimension of the petiole (μm):				
	Length (μm)	694.8	1224.6	912.7
	Width (μm)	487.3	658.4	574.2
No. of vascular bundles		3.0	3.0	3.0
Length of median bundle (μm)		177.4	175.2	218.2
Width of median bundle (μm)		218.2	266.5	274.5

Table (6): Measurements of certain microscopical features in transverse sections of the apical internode of 30 day old plants of the three studied taxa; Cauliflower, Broccoli and Cabbage. (Averages of 10 readings).

Characters	Taxa	Cauliflower	Broccoli	Cabbage
Stem diameter (μm)		1293.4	1022.1	1141.8
Epidermis thickness (μm)		15.5	17.1	18.6
Cortex thickness (μm)		220.7	155.8	155.8
No. of cortex layers		7-9	6-8	9-11
Vascular cylinder thickness (μm)		129.8	129.8	103.8
Pith diameter (μm)		558.1	415.4	584.1

Table (7): Measurements of certain microscopical features in transverse sections of the root of 10 day old plants of the three studied taxa; Cauliflower, Broccoli and Cabbage (Averages of 10 readings).

Characters	Taxa	Cauliflower	Broccoli	Cabbage
Root diameter (μm)		312.2	452.3	389.4
Epidermis thickness (μm)		12.4	15.5	12.4
Cortex thickness (μm)		90.9	142.8	129.8
No. of cortex layers		3-4	4-5	4-5
Vascular cylinder diameter (μm)		103.8	129.8	103.8
No. of xylem arms		4.0	4.0	4.0

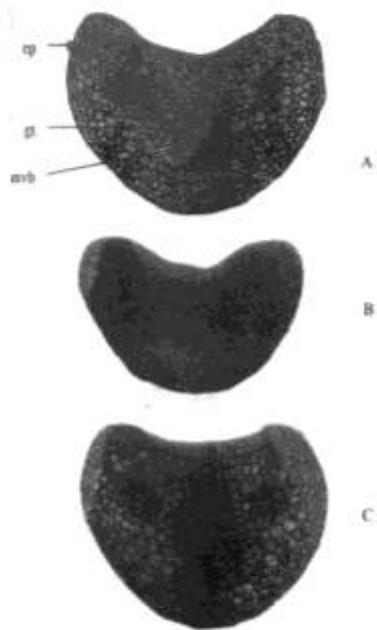


Fig. 15) Transverse sections of leaf primordia of 30-day-old plants of *Brassica oleracea* var. *botrytis*: (A) Cauliflower; B. broccoli var. *italica*; (B) Broccoli; and C. *oleracea* var. *capitata* (Cabbage). Details: ep, epidermis; gr, ground tissue; mvb, median vascular bundle (A/B).

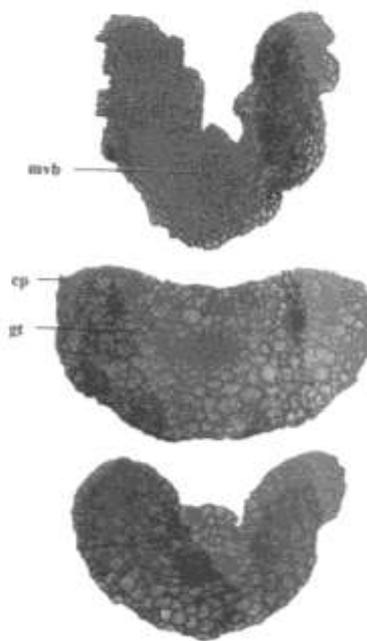


Fig. 16) Transverse sections of leaf primordia of 35-day-old plants of *Brassica oleracea* var. *botrytis*: (A) Cauliflower; B. broccoli var. *italica*; (B) Broccoli; and C. *oleracea* var. *capitata* (Cabbage). Details: ep, epidermis; gr, ground tissue; mvb, median vascular bundle (A/B).

four arms. The metaxylem occupies the center instead of pith tissue, as the secondary growth started.

3.2.4.3 Cabbage

The net is round in outline (Fig. 8C), with a diameter of 389.4 µm. Thickness of epidermis is 12.4 µm. The cortex thickness is 129.8 µm and consists of 4-5 layers. The vascular cylinder (193.8 µm in diameter) occupies the central portion. There are four xylem arms. The primary xylem

occupies the center of the vascular cylinder due to the early starting of secondary growth.

3.2.5 Seed surface sculpture characters

The studied characters of seed surface sculpture as shown by SEM are illustrated in Plate 1 (A and B). Seed surface sculpture of cauliflower is runcinate-pustulate (intermediate between runcinate and pustulate). Broccoli seed surface has runcinate with weak reticulate sculpture

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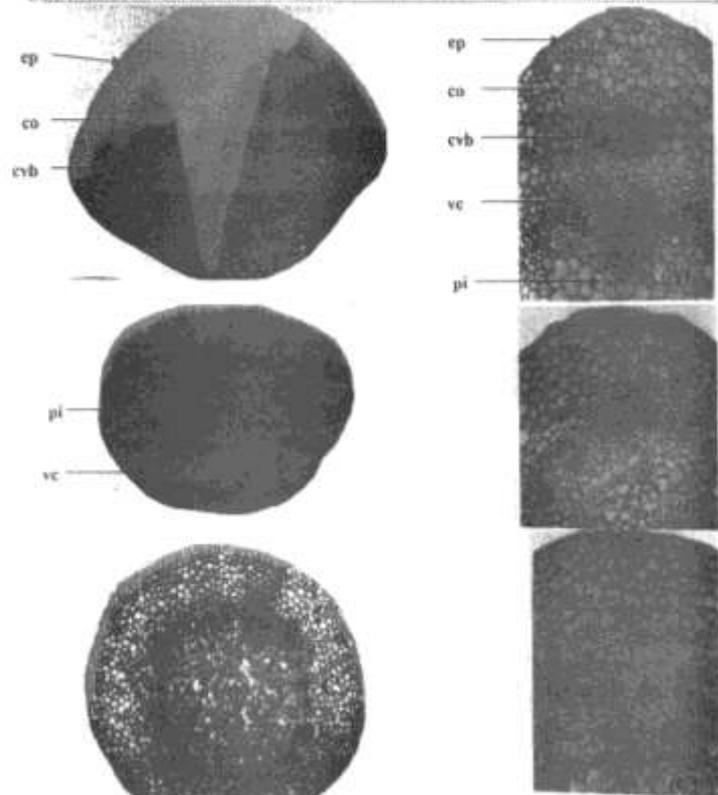


Fig. (7): Transverse sections at (X40) to the left and X 100 to the right of stem of 30 day old plants of *Brassica oleracea* var. *botrytis* (A) Cauliflower, *B. oleracea* var. *italica* (B) (Broccoli) and *Brassica oleracea* var. *capitata* (C) Cabbage. *co*, cortex; *cvb*, cortical vascular bundle; *ep*, epidermis; *pi*, pith; *vc*, vascular cylinder.

shape. On the other hand, the epidermal cells of seed surface of cabbage have reticulate-rugose sculpture shape.

Conclusions

From the previous results it is concluded that, in spite of the high similarity between the three studied taxa in seedling stage and seed shape, it is possible to differentiate between them by using some macro- and micro-morphological characters such as margin and base of leaf lamina, seed and hilum colour and seed surface sculpture. On the other hand,

the anatomical differences were not of value to differentiate between the three plants in regard to leaf lamina, petiole, stem and root.

In order to ease differentiation between the investigated taxa it seems likely to construct an artificial key which would be of value in this respect.

- a. Leaf tip obtuse
- b. Margin of leaf serrated and base three-angulate, seed surface sculpture reticulate rugose and seed colour light brown to light grey. (Cabbage).

bb. Margin of leaf crenatus and base inaequilaterus, seed surface sculpture rinate pustulate and seed colour light brown to dark grey.
(Cauliflower)

iii. Leaf tip round, leaf margin crenus and base truncatus, seed surface sculpture rinate with weak reticulate and seed colour red to light red.
(Broccoli)

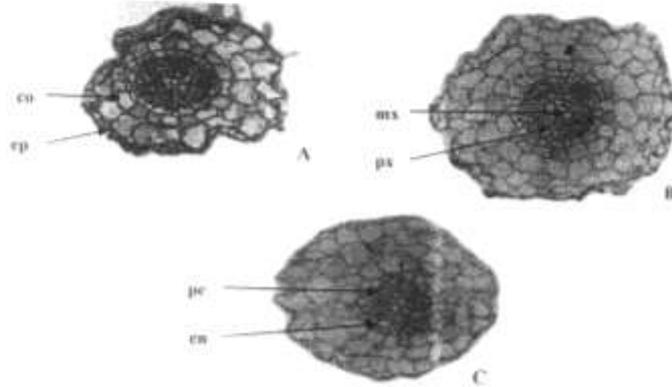


Fig. (10). Transverse sections of root of 10-day old plants of *Brassica oleracea* var. *botrytis* (A) (Cauliflower), *B. oleracea* var. *italica* (B) (Broccoli) and *B. oleracea* var. *capitata* (C) (Cabbage). Details: co, cortex; ep, epidermis; en, endodermis; mx, metaxylem; pc, pith; px, protoxylem. (X100).

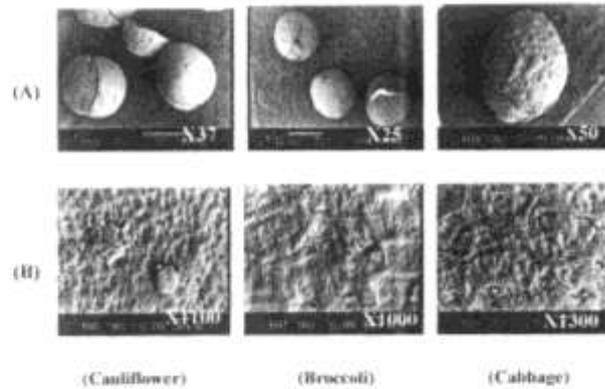


Plate 11: Surface scan of the seed of *Brassica oleracea* var. *botrytis* (Cauliflower), *B. oleracea* var. *italica* (Broccoli) and *B. oleracea* var. *capitata* (Cabbage). (A) Gross morphology of the seed (B) magnified portion of seed coat surface.

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التمييز بين بعض الفئات التصنيفية التابعة لجنس *Brassica* والمتشابهة في شكل البذرة والأعضاء النباتية في المراحل المبكرة للنمو

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ملخص

أجرى هذا البحث في صوبة قسم النبات الزراعي – كلية الزراعة – جامعة القاهرة أثناء الموسم الزراعي 2006 بهدف توضيح الاختلافات بين ثلاث فئات تصنيفية من جنس *Brassica* وهي:
أولاً: (*Brassica oleracea* var. *botrytis* L. (Cauliflower):)
ثانياً: (*B.oleracea* var. *italica* L (Broccoli)
ثالثاً: (*B.oleracea* var *capitata* L. (Cabbage)
وتلك التي تبدو متشابهة في المراحل الأولى للنمو وكذلك في شكل البذرة. أستخدم في هذه الدراسة الصفات المورفولوجية للنبات حتى عمر 30 يوماً وخصائص سطح البذرة باستخدام المجهر الإلكتروني الماسح وكذلك الخصائص التشريحية للأجزاء النباتية المختلفة (نصل و عنق الورقة والساق والجذر).
أوضحت النتائج أن الصفات المظهرية لسطح البذور وكذلك شكل نصل الورقة يعتبر من أهم الصفات التقسيمية للفرقة بين الفئات التصنيفية تحت الدراسة وكذلك صفات: لون البذرة (بنى فاتح الى رمادى غامق فى القنبيط – أحمر الى أحمر فاتح فى البروكلى – بنى فاتح الى رمادى فاتح فى الكرنب) و لون السرة (رمادى غامق

فى القنبىط – بنى فآتح فى البروكلى – رمادى فآتح فى الكرنب) والمسح السطحى للبدور وحادفة وقاعدة نصل الورقة.

ومن ناحفة آخرى كانت الاختلافات التشرىحفة للأجزاء النباتفة بفن الفئات التصنيففة الثلاثة فى المراحل الأولى للنمو (حتى 45 يوما) قليلة الوضوح. ولذلك فان الدراسات التشرىحفة قد تعطى نتائج أفضل للفروق بفن تلك الفئات التصنيففة فى الأعمار المتأخرة.

المجلة العلمفة لكلفة الزراعة – جامعة القاهرة – المجد (60) العدد الأول (بنافر 2009):31-42 .