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**KARYOTYPE CRITERIA OF SOME TAXA OF ASTERACEAE (COMPOSITAE) FROM
SAUDI ARABIA**

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ABSTRACT

Karyotype Features for 12 taxa of Asteraceae (Compositae) from different geographic areas from Saudi Arabia studied. Karyotyping were carried out to construct a karyogram. Chromosome types were determined. All measurements of chromosome length (MCL) and chromosome arm ratio (i.e. MAR) within the karyotype were estimated. Results revealed that eight taxa were found to have a basic chromosome number of $x = 9$. On the other hand, numbers of somatic chromosome varied between $2n = 14$ in the case of *Pulicaria crispa* to a tetraploid of $2n = 32$ *Osteospermum vaillantii*. Most of taxa studied have karyotypes of metacentric to submetacentric chromosomes. Polyploidy numbers of chromosomes were recorded only with *Osteospermum vaillantii* as a tetraploid of $2n = 32$ ($x = 8$). *Launaea capitata* had the longest chromosomes (MCL=6.27±0.33 μm), whereas *Anvillea garcinii* had the shortest chromosomes (MCL 2.21±0.24 μm). All patterns of the studied karyotypes were found to be symmetric with total form percent (TF%) above 40 except *Pluchea dioscoridis* had a TF% of 39.12. The highest value of TF% (47.03) was found in *Anvillea garcinii*. Conclusively, the values of TF%, calculated MAR, intra-chromosomal asymmetry index (A_1) and inter-chromosomal asymmetry index (A_2) for the studied species are supportive to the assumption that the karyotype in the family were symmetrical.

Keywords: Karyotype Features, Asteraceae (Compositae) Taxa, Chromosomes , Saudi Arabia Flora

INTRODUCTION

Regarding the flora of Saudi Arabia, the different ecosystems and diversity of plant species comprises an important genetic resources for crops and medicinal plants [1-3]. Collenette [4] reported that the components of this flora represent Asia, Africa and Mediterranean regions plants and comprises 2250 species belonging to 835 genera and about 142 families. 147 species are classified as endemic, 721 species as endangered and about 22 species are completely extinct.

Recently, the flora of Saudi Arabia was reported to contain about 2253 species and represent 132 families, out of which about 20 % are rare plants. Around 37 families of them are represented by a single species. About 70% of the floristic elements of Saudi Arabia are presented across southwestern mountainous region, from Taif to Yemen border. Many authors have studied the Wild plants of Saudi Arabia as general floral studies [5-8]. Recently, others have studied more limited areas in order to explain floral and taxonomical revision of some genera [9-15].

For many decades, chromosomes were valid taxonomic criteria and, thus, considered to be systematically informative. The classification of a number of families has been either aided or substantiated by information from chromosome features as chromosome size, the

position of the centromere and special banding patterns [16-18].

The chromosomes provided a range of chromosomal possibilities for monitoring the limitations, affinities and evolution of taxa. Many investigators have illustrated that the karyotype morphology could be a useful guide to taxonomic relationships [19-23].

Chromosome counts reported for wild plants of Saudi Arabia are very few, these reports included the works of Badr & Gasim [24], Al-Turki *et al.* [25] and Sharawy *et al.* [26].

In this work, numbers of chromosomes and detailed karyotype characteristics of 12 taxa of Asteraceae collected from different locations in Saudi Arabia were studied.

MATERIALS AND METHODS

Plant material

Twelve taxa of the Asteraceae (Compositae) were obtained from various habitats in Saudi Arabia between 2014-2015 (table 1)

Karyotyping

Slides prepared from root tips of seeds germinated at 20-25°C on a sterile moist filter paper in Petri dishes were subjected to karyotyping. Root tips were pretreated with 0.05% colchicine solution for 3-4 hrs. and fixed in Carnoy for 24 hr. Cytological preparations were made using the Feulgen squash method [27]. The well-spread c-

metaphase chromosomes were photographed from temporary slides at magnifications of 2000 x. A karyogram for the homologous pairs for each taxon were constructed depending on their length and arm ratio. Chromosome types were determined as described by Levan *et al.*

[28].

Statistical analysis:

One-way ANOVA test was used to determine differences among means by using software program of Statistical Analysis [29].

Table [1]: The studied taxa of *Astercaee* (Compositae) from Saudi and their sources & localities.

No.	Taxa	Sources & locality	*PCC/(2n)
1	<i>Anthemis indurata</i> Delile.	Wadi Zimmah (60 Km Makkah – Al-Taif Road)	18
2	<i>Anthemis melampodina</i> Del. subsp. <i>deserti</i> (Boiss.) Eig.	Wadi Al-Madik (70 Km Makkah – Al-Taif Road)	18
3	<i>Anthemis pseudocolula</i> Boiss. = <i>A. rotata</i> Boiss.	Wadi Zimmah (60 Km Makkah – Al-Taif Road)	18
4	<i>Anvillea garcinii</i> (Burm. fil.) DC.	Wadi Ze Ghazal in Al-Shafaa	14
5	<i>Artemisia abyssinica</i> Sch.-Bip.	Wadi Saulah (80 Km Makkah – Al-Taif Road)	18
6	<i>Centaurea pseudosinaica</i> Czerep.	Al-Hada – Al-Taif Road	18
7	<i>Chrysanthemum coronarium</i> L.	Al-Hada – Al-Taif Road	18
8	<i>Launaea capitata</i> (Spreng.) Dandy.	Al-Hada – Al-Taif Road	18
9	<i>Pluchea dioscoridis</i> (L.) DC.	Wadi Ze Ghazal in Al-Shafaa	14
10	<i>Osteospermum vaillantii</i> (Decne.) Norl.	Al-Hada – Al-Taif Road	32
11	<i>Pulicaria crispa</i> Sch. Pip. = <i>Francoeuria crispa</i> Cass.	Wadi Ze Ghazal in Al-Shafaa	14
12	<i>Sonchus oleraceus</i> L.	Al-Azizia Road - Makkah	16

*Previous Chromosome Count

RESULTS

Results of the cytological features of the investigated taxa are shown in Tables (2&3) and the karyotypes are illustrated in Figures (1 & 2).

1- *Anthemis indurata delile*.

The examined material of this species was found to be diploid with a somatic chromosome number of $2n=18$ and basic number of $x=9$. The karyotype is comprised of metacentric chromosomes. The chromosomes are long (MCL= 5.13 ± 0.29 μm), the MAR is 1.24 ± 0.05 and TF% is 44.89. The symmetry of the karyotype is also indicated by the values of A_1 (0.18) and A_2 (0.17).

2- *Anthemis melampodina del. subsp. deserti (boiss.) eig.*

This species has a somatic chromosome number of $2n=18$ in 9 homologous pairs. The karyotype consists of 8m and 1sm chromosome pairs. The MCL is 3.08 ± 0.17 μm , the MAR is 1.45 ± 0.14 , the TF% is 41.07, the A_1 is 0.30 and the A_2 is 0.17.

3- *Anthemis pseudocolula boiss. = a. rotata boiss.*

A somatic chromosome number of $2n=18$ in 9 homologous pairs was recorded in this species. The karyotype consists of 1M, 6m and 2sm chromosome pairs. The MCL is 4.20 ± 0.18 μm ,

the MAR is 1.52 ± 0.19 , the TF% is 41.89, A_1 is 0.27 and A_2 is 0.13.

4- *Anvillea garcinii* (burm. fil.) dc.

The examined material of this species has only $2n=14$ and $x=7$. The karyotype is comprised of 2M and 5m pairs. The MCL is $2.21 \pm 0.24 \mu\text{m}$ and the MAR is 1.14 ± 0.07 . The asymmetry of the karyotype is reflected by the values of TF% (47.03), A_1 (0.11) and A_2 (0.29).

5- *Artemisia abyssinica* sch.-bip.

In this species a somatic number of $2n=18$ and $x=9$ were found. The karyotype consists of short metacentric chromosomes. The MCL is $3.77 \pm 0.17 \mu\text{m}$. The MAR is 1.33 ± 0.07 and the TF% is 43.26. The karyotype asymmetry indices A_1 and A_2 are 0.24 and 0.13, respectively.

6- *Centaurea pseudosinaica* czerep.

A somatic chromosome number of $2n=18$ in 9 homologous pairs of metacentric chromosomes was recorded in this species. The calculated MCL is $3.40 \pm 0.31 \mu\text{m}$ and MAR is 1.30 ± 0.05 . The TF% is 43.72, the A_1 is 0.22 and A_2 is 0.27.

7- *Chrysanthemum coronarium* l.

The examined material of this species was found to be diploid with a somatic chromosome number of $2n=18$ and a basic chromosome number of $x=9$. The karyotype of this species consists of 8 pairs of metacentric chromosomes and one pair of submetacentric

chromosomes. The MCL is $4.04 \pm 0.18 \mu\text{m}$. The karyotype symmetry measures i.e. MAR (1.28 ± 0.11), the TF% (45.09), A_1 , (0.18) and the A_2 (0.13) indicate a high degree of symmetry in the karyotype of this species

8- *Launaea capitata* (spreng.) dandy.

This species has a somatic chromosome number of $2n=18$ in 9 homologous pairs. The karyotype consists of 9m chromosome pairs. This species has the longest chromosomes of the species here studied (MCL $6.27 \pm 0.33 \mu\text{m}$). The MAR is 1.24 ± 0.06 . The asymmetry of the karyotype of this species is also indicated by the values of TF% (45.12), A_1 (0.18) and A_2 (0.16).

9- *Pluchea dioscoridis* (l.) dc.

A somatic chromosome number of only $2n=14$ and $x=7$ are also recorded in this species. The karyotype consists of 4m and 3sm chromosome pairs. The chromosomes of this species are also short (MCL= $3.36 \pm 0.17 \mu\text{m}$). The MAR is 1.64 ± 0.06 . TF% (39.12) is lower reflecting the presence of submetacentric chromosomes in the karyotype. The karyotype asymmetry is also reflected by the indices of A_1 and A_2 viz. 0.36 and 0.13, respectively.

10- *Osteospermum vaillantii* (decne.) norl.

This species has a tetraploid somatic chromosome number of $2n=32$ in 8 homologous pairs. The karyotype is composed of eight metacentric chromosome pairs. The

MCL is $3.95 \pm 0.22 \mu\text{m}$, MAR is 1.24 ± 0.06 and the TF% is 45.15. The karyotype symmetry is also indicated by A_1 and A_2 values (0.18 and 0.16, respectively).

11- *Pulicaria crispa* sch. pip. = *francoeuria crispa* cass.

The examined material of this species was found to be diploid with a somatic chromosome number of only $2n=14$ and a basic chromosome number of $x=8$. The karyotype of this species consists of 4 pairs of metacentric chromosomes and three pairs of submetacentric chromosomes. The MCL is $2.93 \pm 0.24 \mu\text{m}$. The karyotype symmetry

measures i.e. MAR (1.50 ± 0.12), the TF% (40.04), A_1 (0.31) and the A_2 (0.22) indicate a degree of symmetry in the karyotype of this species.

12- *Sonchus oleraceus* L.

The examined material of this species was found to be diploid with a somatic chromosome number of $2n=16$ and basic number of $x=8$. The karyotype is comprised of metacentric chromosomes in eight groups. The chromosomes are short (MCL= $2.59 \pm 0.17 \mu\text{m}$), the MAR is 1.31 ± 0.05 and TF% is 43.35. The symmetry of the karyotype is also indicated by the values of A_1 (0.22) and A_2 (0.18).

Table [2]: Measurements of somatic chromosomes of the studied taxa of *Astercaee* (Compositae) from Saudi Arabia

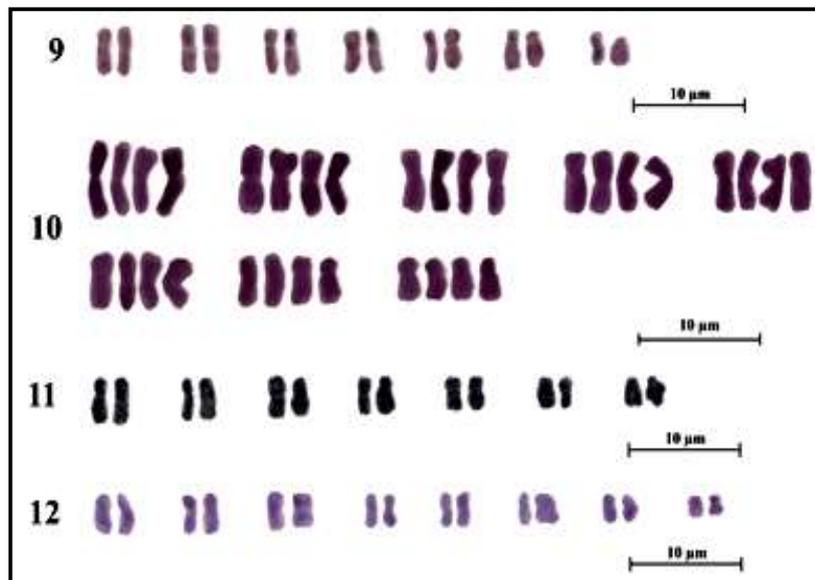
Taxa	CP	CL (μm) Mean \pm SE	Total RRV	SA (μm) Mean \pm SE	LA (μm) Mean \pm SE	RV Mean \pm SE	Total RRV	Chr.type
1- <i>Anthemis indurata</i> Delile.	1-9	5.13 ± 0.29	99.99	$2.30 \pm 0.16^*$	$2.83 \pm 0.15^*$	1.24 ± 0.05	99.99	m
2- <i>Anthemis melampodina</i> Del. subsp. <i>deserti</i> (Boiss.) Eig.	1-9	$3.08 \pm 0.17^*$	100.01	1.27 ± 0.08	1.81 ± 0.09	1.45 ± 0.14	99.99	m (except CP3(sm))
3- <i>Anthemis pseudocolula</i> Boiss. = <i>A. rotata</i> Boiss.	1-9	4.20 ± 0.18	99.98	1.76 ± 0.16	2.44 ± 0.09	1.52 ± 0.19	100.01	m {except CP2 (M), CP8+9 (sm)}
4- <i>Anvillea garcinii</i> (Burm. fil.) DC.	1-7	$2.21 \pm 0.24^*$	99.99	1.04 ± 0.12	1.17 ± 0.12	1.14 ± 0.07	100.00	m {except CP1+7 (M)}
5- <i>Artemisia abyssinica</i> Sch.-Bip.	1-9	$3.77 \pm 0.17^*$	99.99	1.63 ± 0.10	2.14 ± 0.09	1.33 ± 0.07	100.01	m
6- <i>Centaurea pseudosinaica</i> Czerep.	1-9	$3.40 \pm 0.31^*$	99.98	1.48 ± 0.14	1.91 ± 0.17	1.30 ± 0.05	100.00	m
7- <i>Chrysanthemum coronarium</i> L.	1-9	4.04 ± 0.18	100.00	1.82 ± 0.13	2.22 ± 0.06	1.28 ± 0.11	100.01	m {except CP9(sm)}
8- <i>Launaea capitata</i> (Spreng.) Dandy.	1-9	6.27 ± 0.33	100.01	$2.83 \pm 0.20^*$	$3.44 \pm 0.16^*$	1.24 ± 0.06	100.00	m
9- <i>Pluchea dioscoridis</i> (L.) DC.	1-7	$3.36 \pm 0.17^*$	100.01	1.31 ± 0.12	2.05 ± 0.08	1.64 ± 0.15	100.00	m {except CP3+6+7 (sm)}
10- <i>Osteospermum vaillantii</i> (Decne.) Norl.	1-8	$3.95 \pm 0.22^*$	100.01	1.78 ± 0.13	2.17 ± 0.10	1.24 ± 0.06	100.01	m
11- <i>Pulicaria crispa</i> Sch. Pip. = <i>Francoeuria crispa</i> Cass.	1-7	$2.93 \pm 0.24^*$	100.00	1.17 ± 0.08	1.75 ± 0.18	1.50 ± 0.12	100.01	m {except CP1+2+7 (sm)}
12- <i>Sonchus oleraceus</i> L.	1-8	$2.59 \pm 0.17^*$	99.99	1.12 ± 0.06	1.47 ± 0.11	1.31 ± 0.05	100.00	m

CP: chromosomal pair, CL: chromosomal length, RRV: relative value, SA: short arm, LA: long arm, m: metacentric M = Metacentric chromosome, sm: sub-metacentric, (*): Values are significant at $P \leq 0.05$

Table [3]: Somatic chromosome features of the studied taxa of *Astercaeeae* (Compositae)

No.	Taxa	x	2n	MCL (μm)	MAR (R- value)	TF %	A ₁	A ₂	SAT	Chr. Type					PCC/(2n)
										M	m	sm	st	t	
1	<i>Anthemis indurata</i> Delile.	9	18	5.13 ± 0.29	1.24 ± 0.05	44.89	0.18	0.17	-	-	9	-	-	-	18*
2	<i>Anthemis melampodina</i> Del. subsp. <i>deserti</i> (Boiss.) Eig.	9	18	3.08 ± 0.17	1.45 ± 0.14	41.07	0.30	0.17	-	-	8	1	-	-	18
3	<i>Anthemis pseudocolula</i> Boiss. = <i>A. rotata</i> Boiss.	9	18	4.20 ± 0.18	1.52 ± 0.19	41.89	0.27	0.13	-	1	6	2	-	-	18*
4	<i>Anvillea garcinii</i> (Burm. fil.) DC.	7	14	2.21 ± 0.24	1.14 ± 0.07	47.03	0.11	0.29	-	2	5	-	-	-	14
5	<i>Artemisia abyssinica</i> Sch.-Bip.	9	18	3.77 ± 0.17	1.33 ± 0.07	43.26	0.24	0.13	-	-	9	-	-	-	18*
6	<i>Centaurea pseudosinaica</i> Czerep.	9	18	3.40 ± 0.31	1.30 ± 0.05	43.72	0.22	0.27	-	-	9	-	-	-	18*
7	<i>Chrysanthemum coronarium</i> L.	9	18	4.04 ± 0.18	1.28 ± 0.11	45.09	0.18	0.13	-	-	8	1	-	-	18
8	<i>Launaea capitata</i> (Spreng.) Dandy.	9	18	6.27 ± 0.33	1.24 ± 0.06	45.12	0.18	0.16	-	-	9	-	-	-	18
9	<i>Pluchea dioscoridis</i> (L.) DC.	7	14	3.36 ± 0.17	1.64 ± 0.15	39.12	0.36	0.13	-	-	4	3	-	-	14
10	<i>Osteospermum vaillantii</i> (Decne.) Norl.	8	32	3.95 ± 0.22	1.24 ± 0.06	45.15	0.18	0.16	-	-	8	-	-	-	32
11	<i>Pulicaria crispa</i> Sch. Pip.= <i>Francoeuria crispa</i> Cass.	7	14	2.93 ± 0.24	1.50 ± 0.12	40.04	0.31	0.22	-	-	4	3	-	-	14
12	<i>Sonchus oleraceus</i> L.	8	16	2.59 ± 0.17	1.31 ± 0.05	43.35	0.22	0.18	-	-	8	-	-	-	16

MCL :Mean Chromosome Length, MAR : Mean Arm Ratio, SE : Standard Error, TF% :Total Form percent, A₁ : intrachromosomal asymmetry index, A₂ : interchromosomal asymmetry index, SAT : A satellite, Chr. :Chromosome, M : Metacentric chromosome, m : metacentric region chromosome, sm : submetacentric chromosome, st : subtelocentric chromosome, t : Acrocentric chromosome & * : New chromosome record, PCC : Previous Chromosome Count



Figure[1]: Karyotypes of the studies taxa of *Astercaeeae* (1) *Anthemis indurata* Delile., (2) *Anthemis melampodina* Del. subsp. *deserti* (Boiss.) Eig., (3) *Anthemis pseudocolula* Boiss. = *A. rotata* Boiss., (4) *Anvillea garcinii* (Burm. fil.) DC, (5) *Artemisia abyssinica* Sch.-Bip., (6) *Centaurea pseudosinaica* Czerep, (7) *Chrysanthemum coronarium* L, (8) *Launaea capitata* (Spreng.) Dandy.

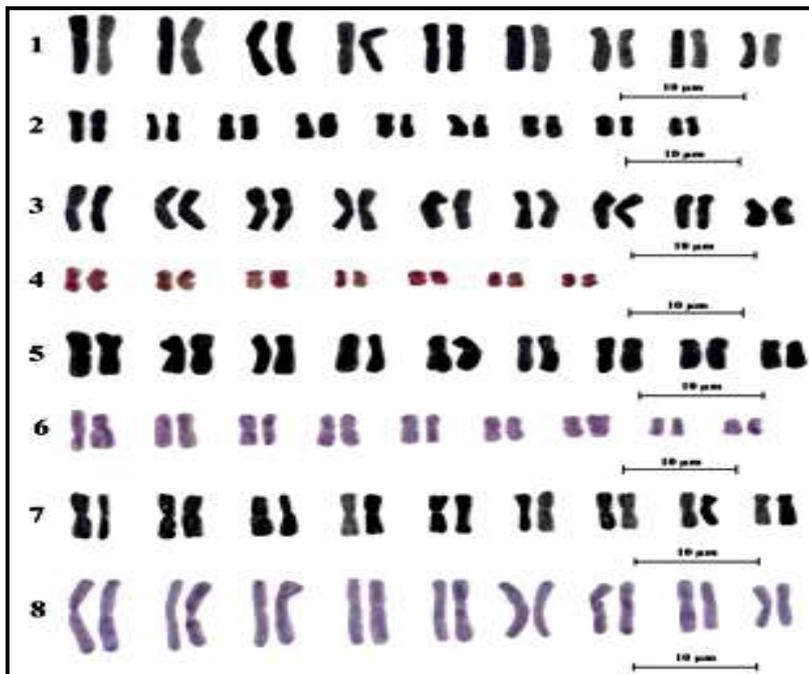


Figure [2]: Karyotypes of the studies taxa of Asteraceae (9) *Pluchea dioscoridis* (L.) DC, (10) *Osteospermum vaillantii* (Decne.) Norl., (11) *Pulicaria crisa* Sch. Pip. = *Francoeuria crisa* Cass. and (12) *Sonchus oleraceus* L.

DISCUSSION

All of the studied taxa of Asteraceae collected from the flora of Saudi Arabia, chromosome counts and karyotype features are observed here for the first time. Of the 12 taxa studied chromosome counts are observed for four species for the first time. These new chromosome counts are recorded in; *Anthemis indurata* Delile. ($2n=18$), *Anthemis pseudocolula* Boiss. ($2n=18$), *Artemisia abyssinica* Sch.-Bip. ($2n=18$) and *Centaurea pseudosinaica* Czerep. ($2n=18$).

The numbers recorded for the other species, i.e. $2n=18$ in *Anthemis melampodina* Del. subsp. *deserti* (Boiss.) Eig. and $2n=14$ in *Anvillea garcinii* (Burm. fil.) DC., are previously reported by Kamel [30]. It was

reported the same chromosome number of $2n=18$ for *Chrysanthemum coronarium* L [31]. On the other hand, previous chromosome counts recorded by Kamel [32] for *Launaea capitata* (Spreng.) Dandy., *Pluchea dioscoridis* (L.) DC. and *Sonchus oleraceus* L. were found to be a tetraploid with $2n=32$, $2n=40$ and $2n=36$ (respectively). For the remaining species chromosome counts were previously reported in chromosome data and.

The karyotype features of species help us as a taxonomic value in providing a logical basis for the redistribution of genera in tribes. In karyotype, symmetrical karyotypes are more primitive than asymmetrical ones, longer chromosomes are more primitive than shorter ones, metacentric chromosomes are more

primitive than sub-metacentric to acrocentric chromosomes, low basic numbers are primitive than high ones [33]. In several instances, studies of karyotype morphology have led the way to a new and fuller understanding of the systematic relationships within a major group of plants and to a complete reorganization of the taxonomic system of the group [34].

In the current study, should be crossed out Seven taxa were found to have a basic chromosome number of ($x = 9$), two taxa were $x = 8$ and three have ($x = 7$). On the other hand, somatic chromosome numbers were varied as $2n = 14$ in three taxa (4, 9 & 11), $2n = 16$ in one taxa (12), $2n = 18$ in seven (1, 2, 3, 5, 6, 7 & 8) and $2n = 32$ only one taxa (10), these results corresponded with observation of Bader et al., [35] when studied some species of *Astercaeeae*

Values of (MCL) varied among the taxa studied (Table 3). The highest value ($6.27 \pm 0.33 \mu\text{m}$) is recorded in the case of *Launaea capitata*, while the lowest value ($2.21 \pm 0.24 \mu\text{m}$) is found in *Anvillea garcinii*. The most variable chromosomes in length are found in *Launaea capitata* (SE of MCL $\pm 0.33 \mu\text{m}$), whereas the most similar chromosomes are scored in *Anthemis melampodina*, *Artemisia abyssinica*, *Pluchea dioscoridis* and

Sonchus oleraceus (SE of MCL $\pm 0.17 \mu\text{m}$), *Astercaeeae*

More karyotype studies should furnish essential information in order to understand the taxonomy and evolution of genera as *Anthemis*, *Artemisia*, *Centaurea*, *Launaea* and *Pulicaria* which are the most common genera of Asteraceae. The wide variation in chromosome length and karyotype formula of *Anthemis* species reported at the time is sufficiently interesting to justify further cytological studies on most wild flora of Saudi Arabia.

CONCLUSION

The karyotype analysis of the studied species shows that *Launaea capitata* has the longest chromosomes, whereas *Anvillea garcinii* has the shortest chromosomes. All studied karyotypes are found to be symmetric with TF% above 40 except *Pluchea dioscoridis* has TF% 39.12. The highest value of TF% (47.03) was found in *Anvillea garcinii*. The calculated MAR, A_1 and A_2 values are generally low in all species supporting the assumption that the karyotype in the family is symmetric.

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