Qatar Univ. Sci. J. (1992), 12: 27 - 57

CONSTITUENTS OF *CENTAUREA* SPECIES

By

H. S. AL-EASA and A. M. RIZK
Scientific and Applied Research Centre, University of Qatar, Doha, Qatar

مكونـــات نباتات الســـنتاوريا

هالـــة سـلطان العيسى و عبد الفتـــاح محمد رزق

تشتهر نباتات السنتاوريا بأحتوائها على سيسكويتربينات لاكتونية وفلافونويدات وبعض هذه المكونات لها تأثيرات بيولوجية مختلفة .

يتنـاول هذا البحث عـرضاً شـاملاً للمكـونات المختلفـة في هذه النبـاتـات (سيسكـويتربينـات لاكتونيـة ـ تربينـات ثلاثيـة ـ كاروتينـات ـ ستيـرويـدات هيدروكربونات ـ فلافونويدات ـ انثوسيانينات ـ أحماض عضوية ـ قلويدات ـ بولي استيلينات ـ كومارينات ـ ليجنانات) ، كما يتناول البحث عرضاً للاستخدامات الطبية لهذه النباتات والخواص البيولوجية للمواد المفصولة منها .

Key Words: Centaurea, Sesquiterpenes, Triterpenes, Carotenoids, Steroids, Hydrocarbons, Flavonoids, Anthocyanins, Organic acids, Alkaloids, Polyacetylenes, Coumarins, Lignansn, Biological activities.

ABSTRACT

A comprehensive review of *Centaurea* species including all the isolated consituents is given. The biological activities of the studied species are also reported.

INTRODUCTION

The family Compositae (Asteraceae) is the largest family of the flowering plants. It includes about 13 tribes, 1,000 genera and 23,000 species. The tribe *Cynarea* of the family Compositae is divided into four subtribes *viz. Carduinea, Carlineae, Centaureinae* and *Echinopsideae*. The subtribe *Centaureinae* is the largest tribe since it comprises a large number of plant genera specially *Centaurea*.

The family Compositae, has been a subject of interest in the past few years to several phytochemical and pharmacological investigatiors, because of its potentially medical and/or economical constituents. Phytochemical studies of the tribe *Centaureinae*, revealed that volatile and non-volatile terpenoids, acetylenes, and flavonoids were the major constituents.

Of the terpenoids, the sesquiterpene lactones predominate over the other terpenoids. The *Centaureinae*, particularly *Centaurea species* are characterized by the occurrence of sesquiterpene lactones of the guaianolide and germacranolide types. Recently, some elemanolides and eudesmanolides have also been isolated from *Centaurea* species[81–83,89,91,94,183].

BIOLOGICAL ACTIVITIES

Centaurea spp. have been used in folk medicine by the natives of some countries as diuretic, antifebrile, antimalarial, mild astringent, stomachic, bitter tonic, digestive, cytotoxic, phytotoxic, antineoplastic, allergenic and emmenagogue. Aslo, certain species that cause livestock poisoning have been reported[12]. For example *C. aspera* was reported to cause hypoglycemia in rats[117–118], *C. follocoa* has antimicribial activity, *C. maculosa* was reported to maintain activities against microorganisms[173], *C. phyllocehala* has antibacteric, toxic as well as hypoglycemic effects[110,173], *C. stenophylla* was reported to be used as a hypoglycemic agent[118], and *C. solistitialis* has toxic allelopathic, cytotoxic, phytotoxic, and causes unique nigropallida encephalomalacia in horses known as "Chewing Disease".

SESQUITERPENE LACTONES

This review covers 132 *Centaurea* species, 82 of them contained sesquiterpene lactones. These are listed in (Table 1). Some of these sesquiterpene lactones have been shown to be biologically active. One of the most exciting findings, is the marked cytostatic activity of chlorinated sesquiterpene lactones, namely, chlorohyssopifolins (1a, 1b, 1c, 1d and 3a) which have been isolated from *C. aegyptiaca*[63,165], *C. adjarica*[138], *C. bella*[138–9], *C. carthalinica*[137,139], *C. colichica*[139], *C. dealbata*[137,139], *C. exsurgens*[139], *C. hypoleuca*[139], *C. hyrcanica*[67,86,139], *C. hyssopifolia*[51,77,81,82,84,86,137,139,157], *C. incana*[86,125], *C. janeri*[139], *C. karabaghensis*[139], *C. linifolia*[86,87,90,137,139], *C. nigra*[81,86,139], *C. picris*[86,137], *C. pullata*[81], *C. repens*[51,55,57,67,73,84,86,123,125,136,168,169], *C. sinaica*[12,13,166], *C. solistitialis*[51,127,137,139,160,163,169], *C. somchetica*[139], *C. taochia*[139] and *C. zangezuri*[137,139]. Cynaropicrin (2i) and deacylcynaropicrin were also reported to suppress cytotoxic activities[90]. Cnicin was reported as a hypoglycemic[109], phytotoxic[111] agent and has antibacterial activity[4,109].

Table 1
Sesquiterpene lactones of *centaurea* species

Sesquiterpene Lactone	Structure #	Species	References
8α-acetoxydehydrocostus lactone	6a	*C. chilensis*	135
		C. floccosa	135
15-acetylartemissifolin	26b	*C. seridis*	80, 86
		C. sonchifolia	94
acroptin	18	*C. repens*	73
aguerin A	2e	*C. arbutifolia*	91
		C. canariensis	54, 88
		C. seventenii	88
aguerin B	2f	*C. alata*	137
		C. arguta	73
		C. behen	137, 141, 158
		C. canariensis	86, 88, 92, 140
		C. hyssopifolia	86, 137
		C. ragusina	121
		C. linifolia	87, 88, 137
		C. repens	168
		C. seventenii	86, 88
amarin	24h	*C. amara*	89
amberboin	13b	*C. lippii*	86
		C. sinaica	12, 13
arbutifolin	24a	*C. arbutifolia*	91
arctiopicrin	24f	*C. melitensis*	31, 76
artemissifolin	26a	*C. castellana*	94
		C. seredis	80, 86
		C. sonchifolia	94
3-besoxycynaropicrin		*C. canariensis*	44
bicyclogermacrene		*C. canariensis*	44
		C. solistitialis	49
γ-cadinene		*C. canariensis*	44
δ-cadinene	33	*C. canariensis*	44
cebellin A	2a	*C. bella*	138
cebellin B	2b	*C. bella*	138
cebellin C	1i	*C. bella*	138
cebellin D	1j	*C. bella*	138
cebellin E	1l	*C. bella*	138
cebellin F	2c	*C. adjarica*	138
		C. bella	138
cebellin G	15a	*C. adjarica*	138
		C. bella	138
cebellin H	15b	*C. bella*	138
cebellin I	3b	*C. adjarica*	138
		C. bella	138
chlorohyssopifolin		*C. hyssopifolia*	90
		C. linifolia	90

Table 1 Contd.

Sesquiterpene Lactone	Structure #	Species	References
chlorohyssopifolin A (centaurepensin)	1a	*C. aegyptiaca*	63
		C. bella	138, 139
		C. carthalinica	137, 139
		C. colchica	139
		C. dealbata	137, 139
		C. exsurgens	139
		C. hypoleuca	139
		C. hyrcanica	139
		C. hyssopifolia	51, 77, 81, 82, 84, 86, 137, 139
		C. janeri	139
		C. karabaghensis	139
		C. linifolia	86, 87, 90, 137, 139
		C. nigra	81, 86, 139
		C. pullata	81
		C. repens	51, 55, 57, 73, 84, 86, 123, 168, 169
		C. sinaica	12, 13, 166
		C. solistitialis	51, 127, 137, 160, 163, 169
		C. somchetica	139
		C. taochia	139
		C. zangezuri	137, 139
chlorohyssopifolin B	1b	*C. aegyptiaca*	63
		C. hyssopifolia	77, 81, 82, 86, 137
		C. linifolia	86, 87, 90, 137
chlorhyssopifolin C (acroptillin)	3a	*C. adjarica*	138
		C. bella	138
		C. carthalinica	137, 139
		C. colchica	139
		C. dealbata	137, 139
		C. exsurgens	139
		C. hypoleuca	139
		C. hyrcanica	67, 86
		C. hyssopifolia	82, 137, 139
		C. incana	86, 125
		C. janeri	139
		C. karabaghensis	139
		C. linifolia	86, 87, 90, 137, 139
		C. nigra	139
		C. picris	86, 137
		C. repens	67, 73, 125, 136, 168, 169
		C. solistitialis	127, 139, 169
		C. somchetica	139
		C. taochia	139
		C. zangezuri	137, 139
chlorohyssopifolin D	1c	*C. hyssopifolia*	82
		C. linifolia	86, 87, 137
chlorohyssopifolin E	1d	*C. aegyptiaca*	165
		C. hyssopifolia	82, 86, 157
		C. linifolia	87, 90, 137
chlorojanerin	1g	*C. aegyptiaca*	63, 84
		C. janeri	85, 86
		C. sinaica	166
chlororepdiolide	1h	*C. repens*	171

Table 1 Contd.

Sesquiterpene Lactone	Structure #	Species	References
clementein	4a	*C. canareinsis*	55
		C. clementei	55, 56, 124
clementein B	4b	*C. canareinsis*	55
		C. clementei	55, 56
clementein C	4c	*C. canareinsis*	55
		C. clementei	55, 56
cnicin	24c	*C. africana*	137
		C. alba	86
		C. beneditus	15
		C. burgueriana	15, 161
		C. calcitrapa	15, 61, 86, 109, 121, 137
		C. castellana	86
		C. cineraria	48
		C. diffusa	60, 86
		C. exarata	137
		C. iberica	61, 86
		C. maculosa	86, 111, 119
		C. micrantha	86
		C. micranthos	62
		C. muricata	37
		C. ovina	61, 86
		C. pallescens	15
		C. pseudomaculosa	3, 4
		C. squarrosa	86, 179
		C. steobe	15, 86, 96, 97, 137
		C. sulphurea	94
cnicin 4'-*O*-acetate	24d	*C. cinerraria*	48
cynaropicrin	2i	*C. amberboa*	137
		C. americana	140, 165
		C. arguta	73
		C. behen	141, 157
		C. canraiensis	54, 86, 88
		C. carthalinica	139
		C. clementie	56, 86
		C. dealbata	137, 139
		C. declinata	139
		C. exarata	137
		C. grossheimia	137
		C. hypoleuca	139
		C. kotschyi	142
		C. leucophylla	139
		C. linifolia	86, 90
		C. muricata	86
		C. repens	168, 169
		C. ragusina	121
		C. seventenii	86
		C. solistitialis	93, 127, 169
		C. tangananesis	94
		C. tricholepis	137
		C. zangezuri	137, 139
deacylcynaropicrin		*C. canariensis*	86
		C. clementie	86
		C. linifolia	86
		C. tangananesis	94
		C. seventenii	86

Table 1 Contd.

Sesquiterpene Lactone	Structure #	Species	References
dehydroartemissifolin		*C. castellana*	94
dehydrocostus lactone	10a	*C. chilensis*	135
dehydromelitesin		*C. amara*	89
11,13-dehydromelitensin	28a	*C. amara*	89
		C. aspera	149
		C. melitensis	81, 83
		C. pullata	81, 83, 86
11, 13-dehydromelitensin-β-hydroxyisobutyrate	29c	*C. melitensis*	31, 83, 86
dehydromelitesin-8-*(O)*-4(4'hydroxymethoarylate)	28d	*C. tangananesis*	94, 137
desacetylcentaurepensin-*O*-(4-hydroxy)tigilinat		*C. imperialis*	159
desacylcynaropicrin		*C. alata*	137
		C. behan	137, 141, 157
		C. canariensis	54, 88
		C. chelinsis	135
		C. clementei	135, 137
		C. floccosa	135
		C. kotschyi	142
		C. ragusina	121
		C. solistitialis	49, 82, 93, 114
		C. tangananesis	94, 137
desacyllinochlorin C		*C. linifolia*	86
8-desacylrepin	3f	*C. aegyptiaca*	165
19-desoxychlorojanerin	1e	*C. aegyptiaca*	63
3-desoxycynaropicrin	6c	*C. canariensis*	44, 54, 137
8-desoxymelitensin		*C. castellana*	94
15-deoxyrepin	3e	*C. carthalinica*	137, 139
		C. colchica	139
		C. dealbata	137, 139
		C. declinata	137, 139
		C. exsargens	139
		C. hypoleuca	139
		C. incana	125
		C. karabaghensis	139
		C. leucophylla	137, 139
		C. somchetica	139
		C. taochia	139
		C. zangezari	139
8-desacylsauprin	2h	*C. aegyptiaca*	165
3-desoxysolistitialin A		*C. imperialis*	159
11,13-dihyroamarin	25a	*C. amara*	89
11,13-dihydroarbutifolin	25c	*C. arbutifolia*	91
11,13-dihydrodeacyl-cynaropicrin	12a	*C. canariensis*	54
		C. chilensis	136
dihydroestafietone	17	*C. webbiana*	78, 86

Table 1 Contd.

Sesquiterpene Lactone	Structure #	Species	References
4β,15-dihydro-3-dehydro-solistitialin A diacetate	19b	*C. behen*	141, 157
4β,15-dihydro-3-dehydro-solistitialin A monoacetate	19a	*C. behen*	141, 157
11α,13-dihydro-8-desacyl-sauprin		*C. aegyptiaca*	63, 165
11,13-dihydroisoarbutifolin		*C. arbutifolia*	91
11,13-dihydromelitesin		*C. aspera*	150
11,13-dihydrosalotinolide	25b	*C. glomerata*	65
11β,13-dihydroxy-8α-epoxymethacryloyloxy-4(15), 10(14),11(13)-trien-(1αH), (5αH)-guain-6,12-olide	16b	*C. collina*	69
3-(3,4-dihydroxy-5-methoxyphenyl)-prop-1-yl-3-hydroxyl-11-methyl octadecanoate		*C. steobe*	96
11β,15-dihydroxysaussurea	30a	*C. castellana*	94
elegin (repinsolide)	1k	*C. repens* *C. solistitialis*	168, 169 169
1(10)en-4α,5β-epoxy- 9α-hydroxygermacranolide--8α-hydroxysencioate	22a	*C. cornopifolia*	144
1(10)en-4α,5β-epoxy-8α-(4-hydroxysenecioate)	22b	*C. cornopifolia*	144
epi-centaurepensin	1m	*C. solistitialis*	169
3-*epi*-11,13-dihydrodeacy-lcynaropicrin	12b	*C. canareinsis*	44, 54
*epi*solistiolide	1n	*C. solistitialis*	127, 169
17,18-epoxy-19-desoxy-chlorojanerin		*C. aegyptiaca*	165
epoxyrepdiolide (desoxyrepin)	3e	*C. aegyptiaca* *C. incana* *C. repens*	165 125 137, 168, 169
germacrene D	27	*C. canareinsis* *C. solistitialis*	44 49
grossheimin	13a	*C. alata* *C. behen* *C. lippii* *C. macrocephala* *C. ornata* *C. ruthenica*	137 137, 141, 157 86 86 86 5
HβH-11,13-dihydrodesacyl-cynaropicrin-8-β-D glucoside		*C. chilensis*	136
8α- (5-hydroxy)-angeloyl-11,13-dehydromelitensin	28b	*C. phrygia*	183
8α-(5-hydroxy)-angeloyl salotenolide	24g	*C. phrygia*	183

Table 1 Contd.

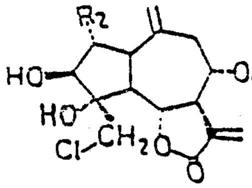
Sesquiterpene Lactone	Structure #	Species	References
3-hydroxy-1,2-dehydrocostic acid methyl ester	34	*C. arguta*	73
9β-hydroxycostus acid		*C. chilensis*	135, 167
8α-hydroxydehydrocostus lactone	10b	*C. canareinsis*	44, 137
		C. chilensis	135, 167
8α-hydroxy-11β,13-H-dehydrocostus lactone	7a	*C. canariensis*	44
3β-hydroxy-8α-epoxymeth-acryloyloxy-4(15),10(14),11(13)-trien-(1αH)(5αH)-guan-6,12-olide	16a	*C. collina*	69
9β-hydroxykandavanolide	20	*C. kandavanesis*	160
1-hydroxy-3-methyl-2-butenoic salotenolide acid ester	24i	*C. glomerata*	65
3-hydroxy-2-methylbutyro lactone		*C. stoebe*	96
*iso*arbutifolin	27c	*C. arbutifolia*	91
*iso*lippidiol		*C. lippii*	86
		C. muricata	86
janerin	3d	*C. adjarica*	138
		C. americana	139
		C. bella	138
		C. carthalinica	137, 139
		C. colchica	139
		C. dealbata	137, 139
		C. exsurgens	139
		C. hypoleuca	139
		C. hyrcanica	139
		C. hyssopifolia	139
		C. incana	125
		C. janeri	86, 139
		C. karabaghensis	139
		C. linifolia	139
		C. nigra	139
		C. phaeopappoides	137
		C. repens	73, 125, 168, 169
		C. sinaica	166
		C. solistitialis	139, 169
		C. somchetica	139
		C. taochia	139
		C. unifolia	18
		C. zangezuri	137, 139
kandavanolide	10c	*C. kandavanesis*	160
linichlorin A	1f	*C. linifolia*	86, 87, 137
linichlorin B	2d	*C. carthalinica*	137
		C. dealbata	137
		C. declinata	137, 139
		C. hypoleuca	139
		C. kotschyi	142
		C. linifolia	86, 87, 137, 139

Table 1 Contd.

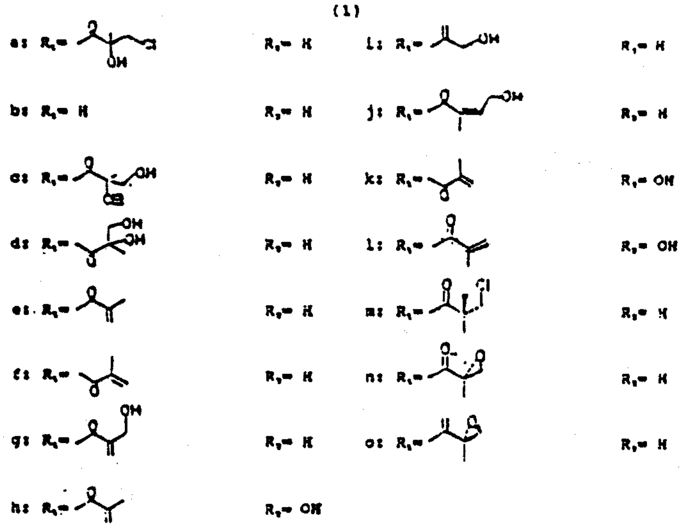
Sesquiterpene Lactone	Structure #	Species	References
		C. leucophylla	137, 139
		C. zangezuri	137
linichlorin C	14	*C. linifolia*	86, 87, 137, 139
lippidiol		*C. muricata*	86
melitesin	29a	*C. amara*	89
		C. aspera	149, 181
		C. melitensis	31, 76, 83, 86
		C. pullata	83
		C. tangananesis	94, 137
melitensin β-hydroxy isobutyrate	28b	*C. melitensis*	31, 83, 86
8α-methacryloyloxyde-hydrocostus lactone	6b	*C. canariensis*	44, 137
muricatin		*C. muricata*	86
onoprodopicrin	24e	*C. melitensis*	31
		C. tangananesis	94, 137
3-oxo-1,2-dehydro-costic acid		*C. canareinsis*	44
3-oxo-1,2-dehydrocostic acid methyl ester		*C. arguta*	73
repdiolide	2g	*C. bella*	138, 139
		C. repens	125, 168, 169, 171
repdiolide triol	8	*C. incana*	125
repin (subteolide)	3c	*C. aegyptiaca*	165
		C. adjarica	138
		C. bella	138, 139
		C. carthalinica	137, 139
		C. colchica	139
		C. dealbata	137, 139
		C. exsurgens	139
		C. hypoleuca	139
		C. hyrcanica	66, 86, 139
		C. hyssopifolia	139
		C. incana	125
		C. janeri	139
		C. karabaghensis	139
		C. linifolia	139
		C. nigra	139
		C. picris	86
		C. repens	73, 81, 168, 169
		C. somchetica	139
		C. solistitialis	127, 139
		C. taochia	139
		C. zangezuri	137, 139
repin[10,11]monochlorohydrin		*C. incana*	125
reynosin	32b	*C. uniflora*	18
salonitenolide	24b	*C. amara*	89
		C. melitensis	31
		C. salonitana	86, 183
		C. stoebe	96

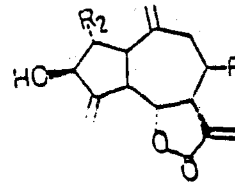
Table 1 Contd.

Sesquiterpene Lactone	Structure #	Species	References
salonitolide	26d	*C. salonitana*	86, 174, 183
		C. seridis	80, 86
salonitolide-8-*O*-(4'-acetoxy-5'-hydroxyangelate)		*C. stoebe*	96
santamarin	32a	*C. uniflora*	18
sauprin	9a	*C. aegyptiaca*	63, 165
sauprin 11α,13-dihydroxy	9b	*C. aegyptiaca*	63, 165
scabiolide	26c	*C. scabiosa*	173
		C. solistitialis	127
sinaicin	21	*C. sinaica*	12, 13
solistitialin		*C. solistitialis*	86, 93, 133, 163, 180
solistitialin A	5b	*C. behen*	141
		C. solistitialis	93, 127, 133
solistitialian acetate	5a	*C. solistitialis*	86, 93, 127, 191
solistitialin A 3-acetate		*C. solistitialis*	127
solistitiolide	1o	*C. repens*	169
		C. solistitialis	127, 169
stenophyllolide	23	*C. aspera*	16, 86, 149, 152
steobenolide		*C. steobe*	96
stizolicin	22c	*C. balsamifera*	86
		C. cornopifolia	144
		C. solistitialis	86, 127, 131, 137
subbexpinnatin	7b	*C. canareinsis*	54, 55, 92
subbexpinnatin B	11a	*C. canareinsis*	54, 55, 92
		C. clemntei	55, 56
subbexpinnatin C	11b	*C. canariensis*	54, 92
		C. clemntei	55, 56
subluteolide	3g	*C. solistitialis*	127, 169
8α-tigloyloxy-2α,3β-di-hydroxy-4α-epoxydehydrocostus lactone		*C. uniflora*	18
vahlenin	30	*C. hyssopifolia*	82, 86, 137
		C. linifolia	86, 87, 137
unidentified sesquiterpene lactones		*C. clemnetei*	53
		C. micrantha	62
		C. repens	51
		C. squarrosa	155
		C. solistitialis	50

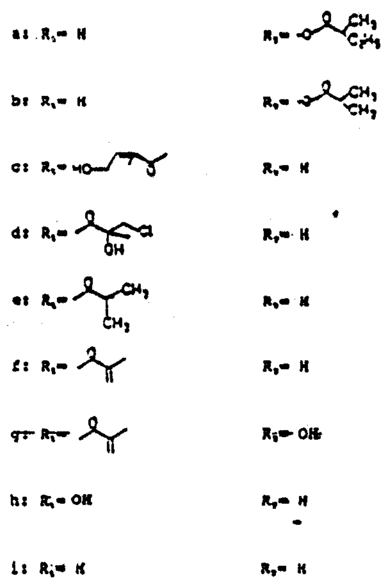


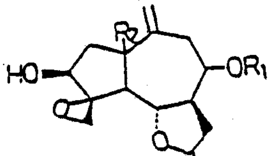
(1)



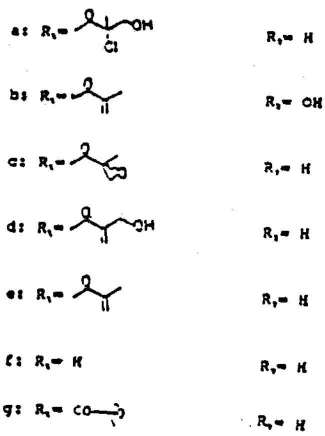


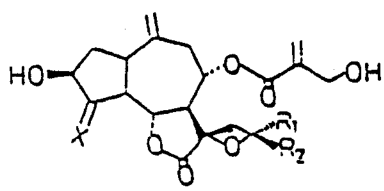
(2)





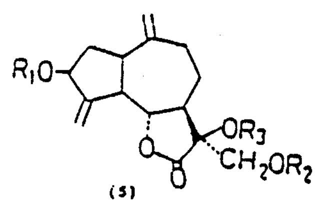
(3)





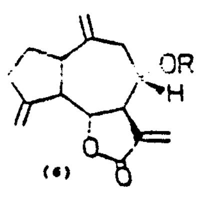
(4)

a:	X= CH_2	R_1= CH_3	R_2= H
b:	X= CH_2	R_1= H	R_2= CH_3
c:	X= H,CH_3	R_1= H	R_2= CH_3

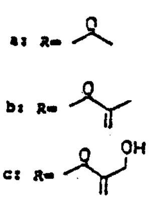


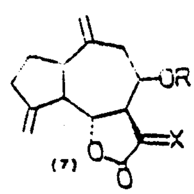
(5)

a:	R_1= H	R_2= H	R_3= Ac
b:	R_1= H	R_2= H	R_3=H

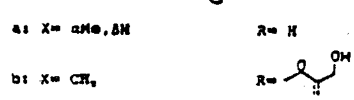


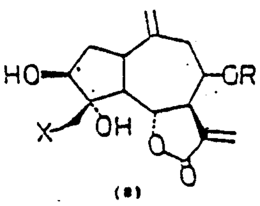
(6)





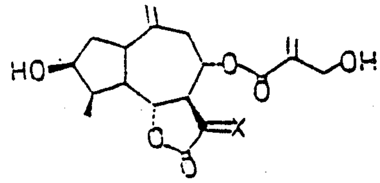
(7)





(8)

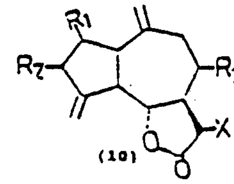
R= X= OH



(9)

a: X= CH_2

b: X= βMe,H(8-desacyl)

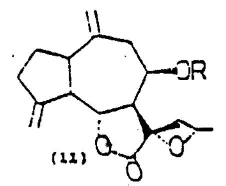


(10)

a: R_1= H R_2= H R_3= H X= CH_2

b: R_1= H R_2= H R_3= OH X= CH_2

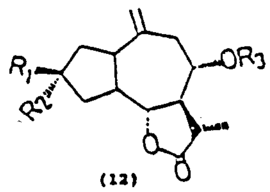
c: R_1= H R_2= OAc R_3= OH X= CH_2



(11)

a: R=

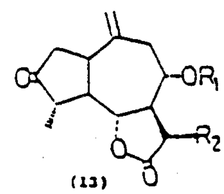
b: R= H



(12)

a: R_1= OH R_2= H R_3= H

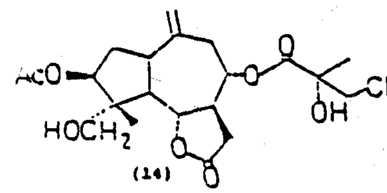
b: R_1= H R_2= OH R_3= H



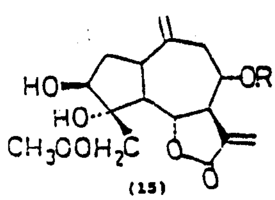
(13)

a: R_1= H R_2= CH_3

b: R_1= H R_2= CH_3



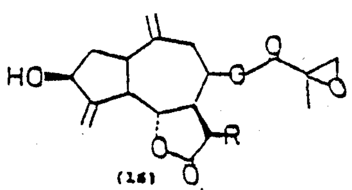
(14)



(15)

a: R=

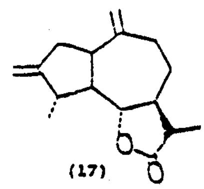
b: R=



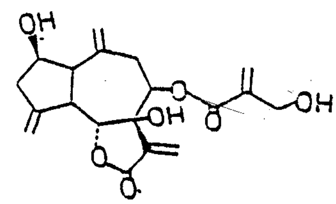
(16)

a: R= CH_2

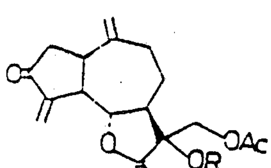
b: R= CH_3



(17)



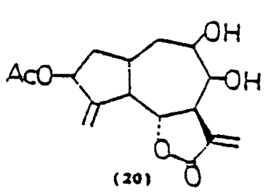
(18)



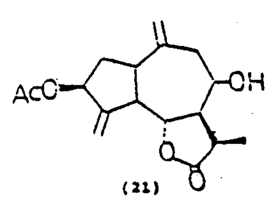
(19)

a: R= H

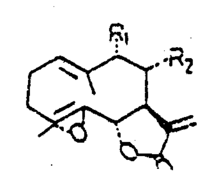
b: R= Ac



(20)



(21)

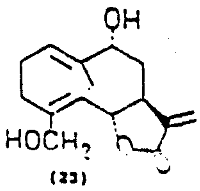


(22)

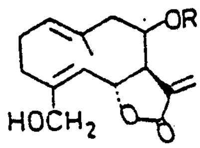
a: R_1= OH R_2=

b: R_1= H R_2=

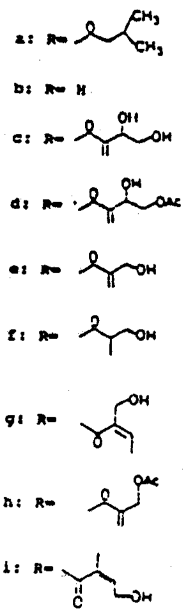
c: R_1= H R_2=

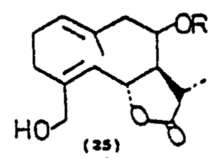


(23)

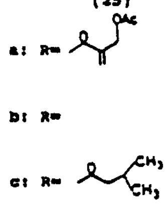


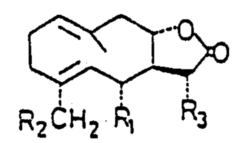
(24)



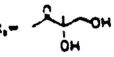


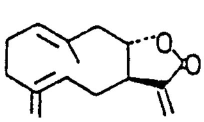
(25)



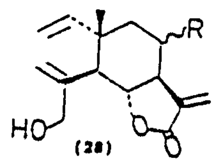


(26)

a:	R_1= OH	R_2= OH	R_3= CH_3
b:	R_1= OAc	R_2= OH	R_3= CH_3
c:	R_1= OAc	R_2= 	R_3= OAc
d:	R_1= OH	R_2= OH	R_3= CH_3

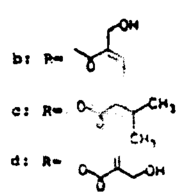


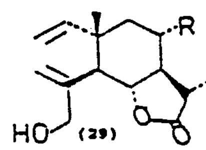
(27)



(28)

a: R= α-OH



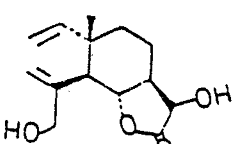


(29)

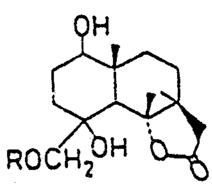
a: R= OH

b: R= OAc

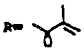
c: R= α-OAc

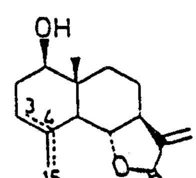


(30)



(31)

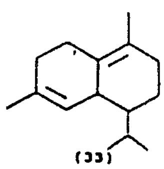
R= 



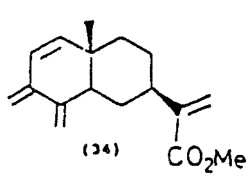
(32)

a: $\Delta^{3,4}$

b: $\Delta^{4,15}$



(33)



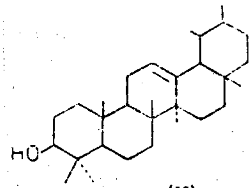
(34)

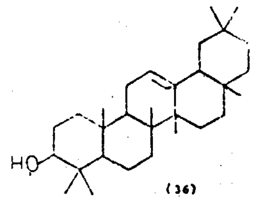
TRITERPENES:

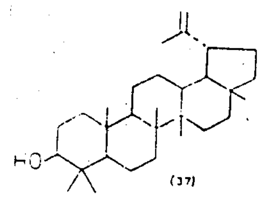
Only 23 *Centaurea* species were found to contain triterpenes (Table 2) three of which were used in folk medicine.

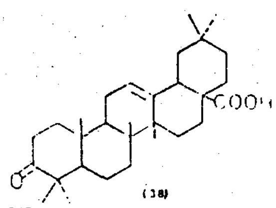
Table 2
Triterpene of *centaurea* species

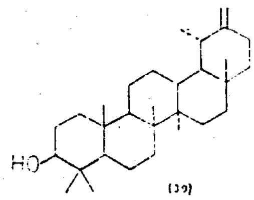
Triterpenoid	Structure #	Species	References
α-amyrin	35	*C. aspera*	151
		C. alexandrin	9
		C. cornipifolia	144
		C. cineraria	64
β-amyrin	36	*C. aspera*	151
		C. arbutifolia	47
		C. calcitrapa	9
		C. cineraria	64
		C. glomerata	9
		C. pallescens	9
aplotaxene		*C. incana*	2
3α-16α-dihydroxytaraxene-3-acetate		*C. solistitialis*	50
hop-17(21)-ene-3-α-ol		*C. phyllocephala*	11
*iso*bauerenyl acetate		*C. aspera*	151
lupeol	37	*C. aspera*	151
		C. ragosina	121
		C. regia	186
		C. sinaica	166
lupeyl acetate		*C. aegyptiaca*	63
		C. ragosina	121
		C. inaica	166
oleanolic acid	38	*C. cunifolia*	146
taraxasterol	39	*C. aegyptiaca*	63
		C. arbutifolia	47
		C. aspera	151
		C. diffusa	128
		C. pseudomaculosa	4
		C. regia	186
		C. repens	97
		C. solistitialis	93
tetrahydroaplotaxene		*C. incana*	2
		C. cyanus	114
		C. melitensis	126
		C. squarrosa	155
		C. solistitialis	50, 51, 93, 126
		C. repens	51
triterpetainene		*C. aegyptiaca*	63
urosolic acid	40	*C. iberica*	10
unidentified triterpenes		*C. aspera*	126
		C. calcitrapa	126
		C. squarrosa	147, 155

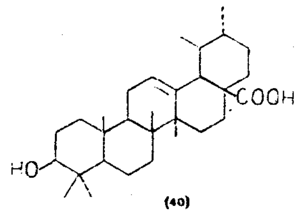

(35)


(36)


(37)


(38)


(39)


(40)

CAROTENOIDS:

Two species were found to contain carotenoids (Table 3).

Table 3
Carotenes of *centaurea* species

Carotene	Species	References
all-trans-luteochrome	*C. moschata*	182
all-trans-neurosprene	*C. moschata*	182
all-trans-β-carotenediepoxide	*C. moschata*	182
aurochrome	*C. moschata*	182
carotene	*C. orintalis*	113
flavochrome	*C. moschata*	182

STEROLS:

Seven sterols were identified from 17 *Centaurea spp.* (Table 4).

Table 4
Steroids of *centaurea* species

Sterol	Species	References
crustecdysone	*C. webbiana*	79
β-sitosterol	*C. aegyptiaca*	63
	C. alexandrina	9
	C. arbutifolia	151
	C. aspera	47
	C. calcitrapa	64
	C. cineraria	9
	C. pallescens	9
	C. pseudomaculosa	3, 4, 92
	C. ragosina	121
	C. regia	186
	C. sinaica	166

Table 4 Contd.

Sterol	Species	References
β-sitosterol-β-D-glucoside	*C. alexandrina*	156, 164
	C. regia	186
	C. seridis	188
sitosteroyl-3β-glucosides 6'-*O*-palmitate	*C. regia*	186
sitosterolglucosides	*C. aspera*	149
stigmasterol	*C. aegyptiaca*	63
	C. aspara	149, 151
	C. sinaica	166
Unidentified steroids	*C. aspera*	126
	C. calcitrapa	126
	C. cyanus	114
	C. iberica	10
	C. melitensis	126
	C. phyllocephala	10, 11
	C. squarrosa	155

HYDROCARBONS:

15 hydrocarbons and related compounds were identified from 19 *Centaurea spp.* (Table 5).

Table 5
Hydrocarbons and related compounds of *centaurea* species

Hydrocarbon	Species	References
$Et\text{-}(CH{=}CH)_4(CH_2)_5O_2CCH_2CHMe$	*C. ruthenica*	43
$Et\text{-}(CH{=}CH)_4(CH_2)_5O_2CCH{=}CMe_2$	*C. ruthenica*	43
$Et\text{-}(CH{=}CH)_4(CH_2)_4OH$	*C. ruthenica*	32
$Et\text{-}(CH{=}CH)_4(CH_2)_4O_2CCH_2CHMe$	*C. ruthenica*	43
$Et\text{-}(CH{=}CH)_4(CH_2)_4O_2CCH{=}CMe_2$	*C. ruthenica*	43
$Et\text{-}(CH{=}CH)_4(CH_2)_4CHO$	*C. cristata*	35
	C. diluta	35
	C. diffusa	35
	C. eriphora	35
	C. involùcrata	35
	C. jacea	35
	C. lippii	35
	C. maculosa	35
	C. micranthos	35
	C. melitensis	35
	C. napifolia	35
	C. pullata	35
	C. sulphurea	35
	C. solistitialis	35
$Me(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_4CH{=}CH_2$	*C. scabiosa*	17
$Me(CH_2)_7CH{=}CH(CH_2)_5CH{=}CH_2$	*C. scabiosa*	17

Table 5 Contd.

Hydrocarbon	Species	References
$MeCH_2(CH=CH)_4(CH_2)_5CHO$	*C. cristata*	35
	C. diluta	35
	C. ferox	35
	C. jacea	35
	C. maculosa	35
	C. micranthos	35
	C. melitensis	35
	C. pullata	35
	C. scabiosa	16
$MeCH_2(CH=CH)_4(CH_2)_6CHO$	*C. cristata*	35
	C. diluta	35
	C. ferox	35
	C. jacea	35
	C. micranthos	35
	C. melitensis	35
	C. pullata	35
	C. scabiosa	17
$MeCH_2(CH=CH)_4(CH_2)_7CHO$	*C. scabiosa*	17
$MeCH_2(CH=CHCH_2)_3(CH_2)_4CH=CH_2$	*C. scabiosa*	17
tetrahecta-4,6-diene-8,10,12-triene-1,3-diol	*C. ruthenica*	98
trans-4-tetradecadiene-8,10,12-triyn-1-ol	*C. ruthenica*	98
trans-6-tetradecadiene-8,10,12-triyn-1-ol	*C. ruthenica*	98
unidentified Hydrocarbons	*C. repens*	51
	C. squarrosa	155

POLYACETYLENES:

Polyacetylenes were reported in 26 *Centaurea* species, (Table 6).

Table 6
Polyacetylenes of *centaurea species*

Polyacetylene	Species	References
6α-acetoxy-2α-(1-*trans*,3-*trans*,9-*trans*-undecatriene-5,7-dinyl--1yl)tetrahydropyran	*C. macrocephala*	41
$AcOCH_2CH=CHC{\equiv}CC=CHCH=CHCH_2CH_2(OAc)Pr$	*C. montana*	120
all-trans-$MeCH=CH(C{\equiv}C)_2(CH=CH)_3H$	*C. ferox*	35
	C. pullata	35
all-trans-$MeCH=CH(C{\equiv}C)_2(CH=CH)_2(CH_2)_3CHO$	*C. angustifolia*	35
	C. involucrata	35
	C. pullata	35
all-trans-$MeCH=CH(C{\equiv}C)_2(CH=CH)_2(CH_2)_4CHO$	*C. angustifolia*	35
	C. involucrata	35
	C. pullata	35
all-trans-$MeCH=CH(C{\equiv}C)_2(CH=CH)_2(CH_2)_5CHO$	*C. angustifolia*	35
	C. involucrata	35
	C. pullata	35

Table 6 Contd.

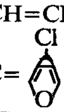
Polyacetylene	Species	References
Centaure X_2: $CH_3CH{=}CH{-}C{\equiv}C{-}C{\equiv}C{-}CH{=}CH{-}CH{=}CH{-}CH_2CHCH_2CH_2OAc$	*C. macrocephala*	120
Centaure X_3: $CH_3CH{=}CH{-}C{\equiv}C{-}C{\equiv}C{-}CH{=}CH{-}CH{=}CH{-}(CH_2)_3{-}CH{=}CH_2$	*C. diluta*	35
Centaure X_4: $CH_3CH{=}CH{-}C{\equiv}C{-}C{\equiv}C{-}CH{=}CH{-}CH{=}CH{-}(CH_2)_4{-}CH{=}CH_2$	*C. ruthenica*	120
CentaureZ:	*C. montana*	120
cis-$H(C{\equiv}C)CH_2CH{=}CH(CH_2)_5Ac$	*C. ferox* *C. pullata*	35 35
cis-cis-$MeCH{=}CH(C{\equiv}C)_2CH_2CH{=}CH(CH_2)_6$	*C. deusta*	36
cis-cis-$MeCH{=}CH(C{\equiv}C)_2CH_2CH{=}CH(CH_2)_7CHO$	*C. deusta*	36
cis-trans-1,2-epoxy-11-tridecen-3,5,7,9-tetrayne	*C. deusta*	36
7-*cis*,14-*trans*-hexadecadiene-10,12-dinyl-1-al	*C. macrocephala*	41
2,2-dimethyl-4-(3-bromopropyl)-1,3-dioxyolane	*C. muricata*	38
2,3-epoxy-12-tridecen-4,6,8,10-tetrayne	*C. deusta*	36
$Et{-}(CH{=}CHCH_2)_3(CH_2)_4CH{=}CH_2$	*C. canariensis*	44
2-hydroxy-6-(*trans*-non-1-ene-3,5,7-trinyl)-tetrahydroxypyran	*C. muricata*	37
I  $C{\equiv}CCH{=}CHCH{=}CH_2$	*C. rudbeckia*	22
$MeC{\equiv}C$  $C{\equiv}CCH{=}CHCH{=}CH_2$	*C. rudbeckia*	22
$Me(C{\equiv}C)_2$  $C{\equiv}CCHClCH_2OAc$	*C. cristata* *C. diluta* *C. melitesis*	35 35 35
$Me(C{\equiv}C)_2$  $C{\equiv}CCH(OH)CH_2Cl$	*C. repens*	170
$Me(C{\equiv}C)_3(CH{=}CH)_2H$	*C. scabiosa*	16
$Me(C{\equiv}C)_3(CH{=}CH)_2(CH_2)_3OH$	*C. scabiosa*	16
$Me(C{\equiv}C)_3(CH{=}CH)_2(CH_2)_5CHO$	*C. scabiosa*	17
$Me(C{\equiv}C)_3(CH{=}CH)_2CHCH_2CH_2Cl$ (OAc, OAc)	*C. scabiosa*	16
$Me(C{\equiv}C)_3CH{=}CH$	*C. muricata*	38
$Me(C{\equiv}C)_4)_4(CH{=}CH)_2H$	*C. scabiosa*	16
$Me(C{\equiv}C)_4CH{=}CH\ CH\ CH_2$ (Cl, OH)	*C. scabiosa*	16
$Me(C{\equiv}C)_5CH{-}CH_2$ (–O–)	*C. scabiosa*	16
$MeCH(C{\equiv}C)_5CH{=}CH_2$	*C. scabiosa*	16
$MeCH{=}CHC{\equiv}C{-}$  $C{\equiv}CCH{=}CH_2$	*C. rudbeckia*	22
$MeCH{=}CH(C{\equiv}C)_2CH{=}CH_2$	*C. diluta*	40
$MeCH{=}CH(C{\equiv}C)_2C{=}$ 	*C. ruthenica*	42
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_4CHO$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_5CHO$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_4CH{=}CH_2$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2CH_2CH{=}CH(CH_2)_5CH{=}CH_2$	*C. scabiosa*	16

Table 6 Contd.

Polyacetylene	Species	References
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2H$	*C. diluta*	40
	C. scabiosa	17
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_3H$	*C. diluta*	40
	C. scabiosa	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2CH_2{=}CH_2CH_2OAc$	*C. diluta*	35
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_2CH_2OH$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH)_3CH_2OH$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_3OH$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_4CH_2OH$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2\underset{OAc}{CH}CH_2\underset{OAc}{CH_2}$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_3CHCHO$	*C. ruthenica*	42
$MeCH{=}CH(C{\equiv}C)_3CH{=}CHCH{=}CH_2$	*C. ruthenica*	42
$MeCH{=}CH(C{\equiv}C)_3CH{=}CHCH{=}CHO_2Et$	*C. ruthenica*	33
$MeCH{=}CH(C{\equiv}C)_3CH{=}CHCH_2OAc$	*C. ruthenica*	42
$MeCH{=}CH(C{\equiv}C)_3CH{=}CHCHClCH_2OAc$	*C. ruthenica*	33
$MeCH{=}CH(C{\equiv}C)_3CH{=}CH\underbrace{CH{-}CH_2}_{O}$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_3CH{=}CH\underset{OH}{CH}{-}\underset{OH}{CH_2}$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_3CH{=}CH\underset{OCl}{CH}{-}\underset{OH}{CH_2}$	*C. scabiosa*	16
$MeCH{=}CH(C{\equiv}C)_4\underbrace{CH{-}CH_2}_{O}$	*C. scabiosa*	16
$MeCH{=}CHC{\equiv}C$  $C{\equiv}CCH{=}CHCH{=}CH_2$	*C. jacea*	35
$MeCH{=}CHC{\equiv}C$  $C{\equiv}C{-}CH{=}CH_2$	*C. jacea*	35
$MeCH{=}CHC{\equiv}C$  —I	*C. rudbeckia*	22
$OHCCH{=}CH(C{\equiv}C)_2(CH{=}CH)_2(CH_2)_4CH{=}CH_2$	*C. napifolia*	35
	C. scabiosa	16
trans-cis-$MeCH{=}CH(C{\equiv}C)_2CH_2CH{=}CH(CH_2)_6CHO$	*C. deusta*	36
trans-cis-$MeCH{=}CH(C{\equiv}C)_2CH_2CH{=}CH(CH_2)_7CHO$	*C. deusta*	36
trans-$Me(C{\equiv}C)_3CH{=}CHCH(OH)(CH_2)_3CH_2OAc$	*C. muricata*	37
trans-$Me(C{\equiv}C)_3CH{=}CHCH(OH)(CH_2)_3CH_2OH$	*C. muricata*	37
trans-$Me(C{\equiv}C)_4CH{=}CHCH(OH)CH_2Cl$	*C. ruthenica*	43
trans-$Me(C{\equiv}C)_4CH{=}CHCH(OAc)CH_2Cl$	*C. ruthenica*	43
trans-$Me(C{\equiv}C)_4CH{=}CH\underbrace{CH{-}CH_2}_{O}$	*C. cristata*	35
	C. diffusa	35
	C. eriphora	35
	C. ferox	35
	C. involucrata	35
	C. lippii	35
	C. maculosa	35
	C. micranthos	35
	C. melitensis	35
	C. solistitialis	35
trans-$MeCH{=}CH(C{\equiv}C)_4CH{=}CH_2$	*C. angustina*	35
	C. canariensis	35

Table 6 Contd.

Polyacetylene	Species	References
	C. cristata	35
	C. diluta	35
	C. diffusa	35
	C. eriphora	35
	C. ferox	35
	C. involucrata	35
	C. jacea	35
	C. lippii	35
	C. maculosa	35
	C. melitensis	35
	C. micranthos	35
	C. napifolia	35
	C. sulphurea	35
	C. scabiosa	17
	C. solistitialis	35
trans-trans-Me(C≡C)$_3$(CH=CH)$_2$(CH$_2$)$_3$CHO	*C. cristata*	35
	C. napifolia	35
	C. pulata	35
trans-trans-Me(C≡C)$_3$(CH=CH)$_2$(CH$_2$)$_4$CHO	*C. cristata*	35
CHC≡C(CH=CH)$_2$CH$_2$	*C. ferox*	35
	C. pullata	35
unidenftified polyacetylenes	*C. canariensis*	44
	C. repens	170
	C. ruthenica	34, 42, 90

FLAVONOIDS:

Reports showed that there were 119 flavonoids of various types isolated form 53 *Centaurea spp.*, (Table 7). Some of these were found to have biological activity; e.g., hispidulin, which was isolated from *C. arguta*[7,46], *C. aspera*[71,72], *C. chilensis*[136], *C. clementei*[44,53,56], *C. floccosa*[134], *C. glomerata*[134], *C. inermis*[143], *C. phyllocephala*[184], *C. urvillei*[185] and *C. virgata*[143] and was found to maintain cytotoxic and antibacterial activities. Apigenin, circimaritin, eupatorin, isoschaftoside, isovitexin, kaempferol 3-*O*-glucoside, kaempferol 3-methyl ether and 6-methoxyluteolin 3′, 4′,7-trimethyl ether were all reported to have antibacterial properties[143]. Apigenin, luteolin and their glycosides are the most common flavonoids in *Centaurea species.*

Table 7
Flavonoids of *centaurea* species

Flavonoid	Structure #	Species	References
acacetin	42a	*C. cuneifolia*	146
		C. pallescens	15
apigenin	41a	*C. alexandrina*	7
		C. aspera	149
		C. calcitrapa	7
		C. deperssa	28
		C. glomerata	7
		C. inermis	143
		C. kilae	143
		C. kotscyi	143
		C. pallescens	15, 145
		C. urivillei	143
		C. virgata	143

Table 7 Contd.

Flavonoid	Structure #	Species	References
apigenin-7-*O*-(4-ethyluronide)		*C. aspera*	70, 71
apigenin 7-*O*-galacturonic methyl ether		*C. alexandrina*	8
		C. calcitrapa	8
		C. glomerata	8
		C. pallescens	8
apigenin 7-*O*-β-D-glucoside		*C. alexadrina*	7, 122
		C. chilensis	136
		C. pallescens	7
		C. urvillei	185
apigenin-4′,*O*-β-D-glucoside 7-*O*-β-D-glucuronide		*C. cyanus*	15, 21, 178
apigenin-4′-O-glucuronide		*C. aspera*	70, 71
apigenin-7-*O*-glucoronide		*C. aspera*	70, 71
apigenin-4'-*O*(6-*O*-malonyl-β-D-glucoside)7-*O*-β-D-glucuronide		*C. cyanus*	178
apigenin-7-methylgalacturonide		*C. calicitrapa*	121
apiin		*C. cyanus*	7
		C. scabiosa	7
astragalin		*C. alexandrina*	8
		C. calcitrapa	8
		C. pallescens	8
		C. glomerata	8
baicillin		*C. scabiosa*	7
centauréidin	44d	*C. glomerata*	7
		C. nigrescens	39
		C. phrygia	39
		C. phsyigia	39
centaurein	44c	*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7
		C. jacea	7, 68, 157, 190
		C. pallescens	7
chrysoeriol	41c	*C. arbutifolia*	7, 47
		C. chilensis	136
		C. floccosa	134
		C. glomerata	134
		C. regia	186
chrysoeriol 7-*O*-glucoside		*C. chelensis*	136
cirsiliol		*C. phyllocephala*	110, 184
		C. sinaica	12
		C. urivillei	185
crisimaritin		*C. behen*	141
		C. kotschyi	145
		C. urvillei	185
cyanocentaurein		*C. cyanus*	20, 176, 178
dihydroquercetin		*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7

Table 7 Contd.

Flavonoid	Structure #	Species	References
		C. pallescens	7
4',7-di-*O*-methyl scutellarein		*C. clementei*	44, 53, 56
eriodictyol		*C. floccosa*	134
		C. glomerata	134
ethyl-7-*O*-apigenin glucuronate		*C. aspera*	149
eupatilin	47	*C. alexandrina*	94
		C. arguta	73
		C. cineraria	48
		C. cunifolia	146
		C. virgata	143
eupatorin		*C. cuneifolia*	146
		C. inermis	143
		C. virgata	143
fisetin	46a	*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7
		C. pallescens	7
genkwanin	41d	*C. cyanus*	19, 21
		C. urvillei	185
7-glucosylaxillarin		*C. solistitialis*	107
7-glucosyl-6-methoxyquercetin		*C. collina*	103
7-glucosylpatuletin		*C. solistitialis*	107
3-glucosylquercetin		*C. colina*	103
		C. solistitialis	107
7-glucosylquercetein		*C. collina*	103, 108
		C. solistitialis	107
7-glucosylspinacetin		*C. solistitialis*	107
helichrysin		*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7
		C. pallescens	7
hesperidin		*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7
		C. pallescens	7
hisidulin	42d	*C. arguta*	7, 46
		C. aspera	71, 72
		C. chilensis	136
		C. clementei	44, 53, 56
		C. floccosa	134
		C. glomerata	134
		C. inermis	143
		C. phyllocephala	184
		C. urvillei	185
		C. virgata	143
homoorientin		*C. melitensis*	105
		C. solistitialis	108
5-hydroxy-3',4',6,7-tetrahydroxy-		*C. burguerina*	161

Table 7 Contd.

Flavonoid	Structure #	Species	References
6-methoxyflavone		*C. cineraria*	48
		C. iberica	10, 11, 80
		C. phyllocephala	10, 11, 80
		C. pseudomaculosa	4, 5
isokaempferide	46g	*C. clemntei*	44, 53, 56
isoquercetrin		*C. deperssa*	28
isorhamnetin	46f	*C. kotschyi*	145
isorhamnetin 3-galactoside		*C. kotschyi*	145
isorhamnetin 7-glucoside		*C. kotschyi*	145
isoschftoside		*C. virgata*	143
isovitexin	42c	*C. melitensis*	105
		C. virgata	143
jaceidin	44a	*C. amara*	74
		C. hyssopifolia	75
		C. kotscyi	143
		C. nigrescens	39
		C. pallescens	15
		C. phrygia	39
jacein	44b	*C. calcitrapa*	7
		C. hyssopifolia	75
		C. jacea	7, 68, 157, 189
		C. pallescencs	7
jaceoside		*C. jacea*	157, 189
jaceosidin	42d	*C. alexandina*	94
		C. arguta	73
		C. aspera	71, 72
		C. behen	143
		C. cineraria	48
		C. cuneifolia	146
		C. inermis	143
		C. kilea	143
		C. pallescens	15
		C. phyllocephala	110, 184
		C. urvillei	143
		C. virgata	143
kaempferol	46d	*C. alexandrina*	8
		C. calcitrapa	7, 8
		C. collina	104
		C. chilensis	136
		C. floccosa	134
		C. glomerata	134
6-methoxyluteolin-3′,4′,7-trimethyl ether		*C. kilae*	143
6-methoxyluteolin-7-glucoside		*C. melitensis*	102
6-methoxyquercetin		*C. collina*	102
7,3-methoxy-*O*-rutin-osylkaempferol		*C. arguta*	45
morin	43	*C. calcitrapa*	7

Table 7 Contd.

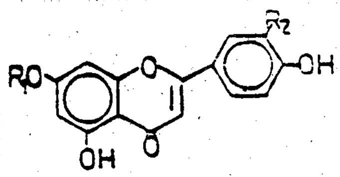
Flavonoid	Structure #	Species	References
		C. pallescence	7
naringenin	49	*C. alexandrina*	7
		C. arguta	7, 46
		C. behen	143
		C. calcitrapa	7, 8
		C. glomerata	7, 8
		C. pallescens	7
neglectin		*C. clementei*	44, 53, 56
nepetin		*C. aspera*	71, 72
		C. inermis	143
		C. phyllocephala	110, 185
		C. urvillei	185
		C. virgata	143
orientin	42f	*C. melitensis*	105
		C. solistitialis	108
paenoside		*C. alexandrina*	7
		C. calcitrapa	7
		C. glomerata	7
		C. pallescens	7
palustrin		*C. clementei*	53
patuletin	48	*C. solistitialis*	106
patulitrin (quercetagetin-6-methyl ether 7-glucoside)		*C. kotschyi*	145
pictolinarigenin		*C. sulphurea*	94
3′,4′,4,6,7-peneta methoxyflavone		*C. jacea*	189
pictolinaroside (glucosyl-3-rhamnosyl-7-quercetin)		*C. kerria*	153
		C. rhus	153
		C. scabiosa	153
		C. sempervirens	153
pinocembrin 7-diglucoside		*C. ragusina*	121
quercermeritrin	46h	*C. cheiranthefolia*	7, 27
		C. ciscausiea	27
		C. cyanus	7, 27
		C. deperssa	28
		C. micranthos	27
		C. nigrifimbria	27
		C. ruthenica	27
		C. solistitialis	27
		C. sumensis	27
quercimerritrin 7-*O*-β-glucopyranoside		*C. apiin*	25
quercermetrin-7-β-*O*-D-glucopyranoside		*C. apiin*	25
quercetagetin 3,6-dimethylether		*C. cornopifolia*	144
quercetagetin-3′,6-dimethylether 7-*O*-glucoside		*C. kotschyi*	145

Table 7 Contd.

Flavonoid	Structure #	Species	References
quercetagetin 3,6-di-methylether 7-*O*-glucoside		*C. cornopifolia*	144
quercetagetin-3′-methyl ether 7-*O*-glucoside		*C. kotschyi*	145
quercetagetin-7-glucoside		*C. kotschyi*	145
quercetin	46c	*C. alexandrina*	7
		C. calcitrapa	8
		C. chilensis	136
		C. collina	104
		C. floccosa	134
		C. glomerata	7, 8, 134
		C. kotscyi	145
		C. solistitialis	106
quercetrin-3,7-disulfate		*C. alexandrina*	122
quercetin-7-*O*-β-D-glucopyranoside		*C. aspiin*	25
rhamnetin	46e	*C. collina*	102
rutin	46b	*C. alexandrina*	7, 8
		C. calcitrapa	7, 8
		C. glomerata	7,8
		C. pallescens	7
rutinoside		*C. sempervirens*	153
7-rutinosy-3-*O*-methyl-kaemferol		*C. arbutifolia*	7, 47
		C. arguta	73
salvigenin	42e	*C. cineraria*	48
		C. cunifolia	146
		C. sinaica	12
		C. urivillei	185
schaftoside		*C. melitensis*	105, 108
		C. solistitialis	108
scutellarin		*C. apiin*	25
		C. deperssa	26, 28
		C. scabiosa	7
4′,7-scutellarein dimethylether		*C. clementei*	56
		C. cunefolia	144
scutellarin-5-*O*-β-D-glucuronide		*C. deperssa*	28
scutellarin-7-*O*-β-D-glucuronide		*C. deperssa*	28
spinacetin	45	*C. kotscyi*	145
		C. solistitialis	106
3′,4′,5,7-tetrahydroxy-6-methoxyflavone		*C. aspera*	72
3′,5,7-trihydroxy-4′,5-dimethoxyflavone		*C. nigrescens*	7
		C. phrygia	7
3′,5,7-trihydroxy-4′,6-dimethoxy-flavone		*C. grinesis*	175

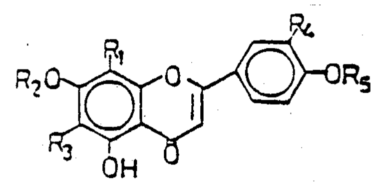
Table 7 Contd.

Flavonoid	Structure #	Species	References
3,4′,7-trihydroxy-3′,6-dimethoxy-flavone		*C. arguta*	46
4′5,7-trihydroxy-3,6-dimethoxy-flavone		*C. jacea*	157
5,7,4′-trihydroxy-3′,6-dimethoxy flavone		*C. arguta*	7, 45
		C. aspera	72
		C. jacea	189
4′,5,7-trihydroxy-3,6-dimethoxy-flavone 7-*O*-β-D-glucoside		*C. jacea*	157
4′,5,7-trihydroxy-8-dimethoxy-flavone		*C. cineraria*	64
taxifolin		*C. floccosa*	134
		C. glomerata	134
vicenin 2		*C. melitensis*	105
vitexin	42g	*C. alexandrina*	7
		C. calcitrapa	7
		C. cyanus	20
		C. glomerata	7
		C. pallescens	7
		C. ragosina	121
		C. regia	186
unidentified flavonoids		*C. alexandrina*	8
		C. aspera	72, 126
		C. aucherana	32
		C. balsamita	32
		C. burgueriana	32
		C. calcitrapa	8
		C. collina	69
		C. deperssa	28, 112
		C. glomerata	8
		C. iberica	23
		C. melitensis	126
		C. nigrescens	39
		C. squarrosa	115
		C. virgata	23



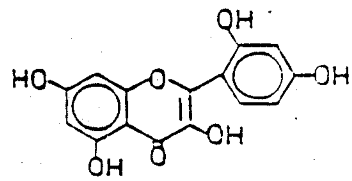
(41)

	R1	R2
a:	H	H
b:	H	OH
c:	H	OCH3
d:	CH3	H

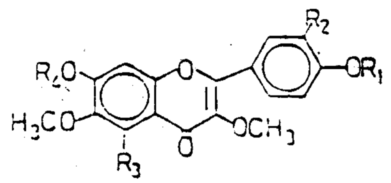


(42)

	R1	R2	R3	R4	R5
a:	H	H	H	H	CH3
b:	H	H	OCH3	H	H
c:	H	H	C-glu	H	H
d:	H	H	OCH3	OCH3	H
e:	H	CH3	OCH3	H	CH3
f:	C-glu	H	H	OH	H
g:	C-glu	H	H	H	H

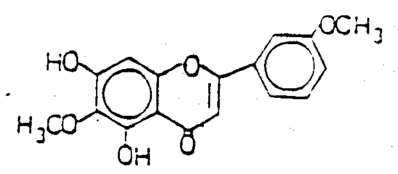


(43)

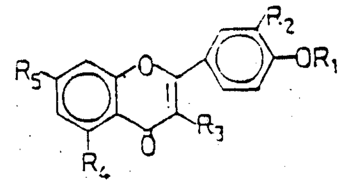


(44)

	R	R	R	R
a:	H	OCH_3	H	H
b:	H	OCH_3	OH	glu
c:	CH_3	OH	OH	glu
d:	CH_3	OH	OH	H

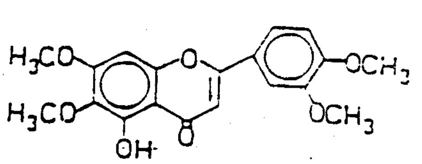


(45)

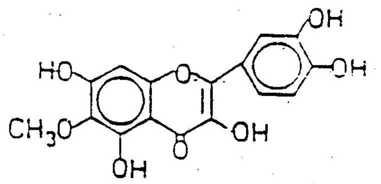


(46)

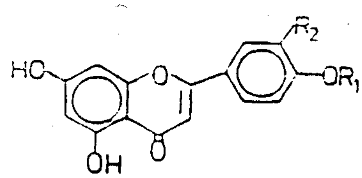
	R	R	R	R	R
a:	H	OH	OH	H	OH
b:	H	OH	O–ru	OH	OH
c:	H	OH	OH	OH	OH
d:	H	H	OH	OH	OH
e:	H	OH	OH	OH	OCH_3
f:	H	OCH_3	OH	OH	OH
g:	H	H	OCH_3	OH	OH
h:	H	OH	OH	OH	O–glu



(47)



(48)



(49)

COUMARINS:

Scopletin, and esculetin, two known coumarins, have been isolated from *Centaurea spp.* The former was isolated from *C. meyriana* and *C. serides*[80], and the latter was isolated form *C. urvillei.* Unidentified coumarins were reported also in *C. deperrsa*[112].

ANTHOCYANINS:

Anthocyanins were reported in 10 *Centaurea* species, mainly of the glycoside types (Table 8).

Table 8
Anthocyanins of *centaurea* species

Anthocyanin	Species	References
centaurocyanin	*C. cyanus*	176
cyanidin 3-(6′-malonylglucoside)	*C. cyanus*	100
cyanidin 3-*O*-(6-*O*-succinyl-β-D-glucoside) -5-β-D-glucoside	*C. cyanus*	175, 178
	C. jacea	175
	C. macroptilon	175
	C. pannonica	175
	C. sadlerana	175
	C. spinulosa	175
cyanidin 3-(6-succinylglucoside)-5-glucoside	*C. jacea*	175
	C. micrantha	175
cyanidin 3-glucoside	*C. cyanus*	20, 176, 178
cyanidin 3,5-*O*-β-D-glucoside	*C. cyanus*	175
cyanin (cyanidin-3,5-diglucoside)	*C. cyanus*	20, 175, 176, 178
3,5-diglucosylcyanidin	*C. cyanus*	101
	C. lugdunensis	101
	C. montana	101
3-glucosylcyanidin	*C. cyanus*	101
	C. lugdunensis	101
	C. montana	101

Table 8 Contd.

Anthocyanin	Species	References
pelargonidin-3-(6″-succinylglucoside)-5-glucoside	*C. cyanus*	175, 177
succinylcyanin	*C. cyanus*	178
unidentified anthocyanins	*C. cyanus*	76, 162
	C. deperss	112

LIGNANS:

Two lignans, arctigetin and (-)-arctigetin were isolated from *C. glomerata* and *C. regia* respectively[65,186].

ORGANIC ACIDS:

Organic acids were identified from 15 *Centaurea* species, (Table 9).

Table 9
Organic acids of *centaurea* species

Acid	Species	References
alkonic	*C. aspera*	151, 152
benzoic	*C. aspera*	126, 149
caffeic	*C. austriaca*	129
	C. cyanus	132
chlorogenic	*C. austriaca*	129
	C. cyanus	132
	C. ciscaucasiea	30
	C. jacea	30
	C. montana	130
	C. orientalis	130
ferulic	*C. pallescens*	15
gibberellic	*C. diffusa*	48
	C. maculosa	187
neochlorogenic	*C. cyanus*	132
p-hydroxybenxoic	*C. aspera*	15, 126, 149
	C. pallescens	15
	C. polypodiifolia	154
	C. regia	186
succinic	*C. cyanus*	174
venillic	*C. regia*	186
unidentified	*C. aspera*	126
	C. calcitrapa	126
	C. melitensis	126
	C. solistitialis	126

ALKALOIDS:

Two alkaloids, brevicepsin and stizoiphine were isolated from *C. berviceps*[115] and *C. calcitrapa*[116b] respectively. The former alkaloid was reported to suppress cardiac activity. Fourteen *Centaurea* species were reported to contain unidentified Alkaloids (Table 10).

Table 10
Alkaloids of *centaurea* species

Alkaloid	Species	References
brevicespsine	*C. breviceps*	115
stizoiphine	*C. calcitrapa*	116b
unidentified alkaloids	*C. alexandrina*	6
	C. balsamita	23
	C. breviceps	23
	C. burgueriana	116a
	C. calicitrapa	6
	C. glomerata	6
	C. iberica	23
	C. koeieana	23
	C. napifolia	172
	C. napulifera	172
	C. pallescens	6
	C. parilica	10, 11
	C. phyllocephala	172, 184
	C. repens	1
	C. solistitialis	50, 51
	C. squarrosa	24, 155

REFERENCES

1. **Abduazimov, Kh. A., A. Abdusamatov, and Yu. Yunusov, 1960.** Dokl. Akad. Nauk Uz. SSR, 6: 20-22.
2. **Aclinou, P., A. Boukerb, J. Bouquant, G. Massiot, and L. Le Men-Olivier, 1982.** Plant. Med. phytother., 16(4): 303-309.
3. **Adekenov, S.M., A.Zh. Turmukhambetov, M.N. Mukchanov, and O.A. Abdrakhmanov, 1979.** Deposited Doc. VINITI, 9, 9 pp.
4. **Adekenov, S.M., G.M. Kadirberlina, V.I. Sadykova, T.I. Kupriyanova, and A.D. Kagarlitskii, 1986.** Izv. Akad Nauk Kaz. SSR, Ser. Khim., (3): 65-69.
5. **Adekenov, S.M., K.A. Aituganov, A.D. Kagarutskii, K.D. Rakhimov, and S.M. Vermenichev, 1986.** Khim-Farm. Zh., 20(8): 938-942.
6. **Ahmed, Z.F., F.M. Hammouda, A.M. Rizk, and S.I. Ismail, 1970.** Planta Med., 18(3): 227-231.
7. **Ahmed, Z.F., H. Rimpler, A.M. Rizk, F.M. Hammouda, and S.I. Ismail, 1970.** Phytochem., 9(7): 1595-1601.
8. **Ahmed, Z.F., A.M. Rizk, and F.M. Hammouda, 1970.** Postep Dziedzinie Leku Rosl., Pr. Ref. Dosw. Wygloszone Symp., 20-23.
9. **Ahmed, Z.F., F.M. Hammouda, A.M. Rizk, and S.I. Ismail, 1971.** Planta Med., 19(3): 264-269.
10. **Ahmed, N., and R. Bibi, 1979.** Fitoterapia, 50(5): 199-200.
11. **Ahmed, N., and R. Bibi, 1981.** Fitoterapia, 52(4): 187-188.
12. **Al-Easa, H.S. 1990.** Phd. D. Thesis, University of Reading, Readding England.
13. **Al-Easa, H.S., J. Mann, and A. Rizk, 1990.** Phytochem., 29(4): 1324-1325.
14. **Amer, M.M.A., O.M. Salama, and A.A. Omar, 1984.** Acta Pharm. Jugosl., 34(4): 257-259.
15. **Ali, Y.E., A.A. Omar, T.M. Sarg, and D.J. Slatkin, 1987.** Planta Med., 53(5): 503-504.
16. **Amigo, J.M., T. Debaerdemaeker, E. Seoane, A. Tortajada, and M.T. Picher, 1984.** Phytochem., 23(9): 1999-2001.
17. **Andersen, A.B., J. Lam, and P. Wrang, 1977.** Phytochem., 16: 1829-1831.
18. **Appendino, G., P. Gariboldi, and F. Belliardo, 1986.** Phytochem., 25(9): 2163-2165.
19. **Asen, S. 1967.** Am. Soc. Hort. Sci., 91, 653-659.
20. **Asen, S. 1967.** Phytochem., 6: 577-584.
21. **Asen, S., and R.M. Horowitz, 1974.** Phytochem., 13(7): 1219-1223.
22. **Atkinson, R.E., and R.F. Curtis, 1965.** Tetrahedron, Lett., 5: 297-300.
23. **Aynehchi, Y., M.H.S. Sormaghi, Gh. Amin, M. Khoshkhow, and A. Shabani, 1985.** Int. J. Crude Drug Res., 23(1): 33-41.
24. **Bakenova, M.A. 1963.** Tr. Inst., Bostan., Akad. Naukkoz. SSR, 17: 177-180.
25. **Bandyukova, V.A., E.T. Oganesyan, L.I. Lisevitskaya, V.I. Sidel'nikova, and A.L. Shinkarenko, 1966.** Fenol'nye Soedin. Ikh Biol. Funkts., Mater. Vses. Simp., 95-100.
26. **Bandyukova, V.A., and Kh.Kh. Khalmatov, 1967.** Khim. Prir. Soedin., 3(1): 57-58.
27. **Bandyukova, V.A., 1967.** Khim. Prir. Soedin., 3(1): 58-59.
28. **Bandyukova, V.A., Kh.Kh. Khalmatov, and Kh.I. Alimov, 1969.** Khim. Prir. Soedin., 5(4): 324-325.
29. **Bandyukova, V.A., N.V. Sergeeva, and S.F., Dzhumirko, 1970.** Khim. Prir. Soedin., 6(4): 470-471.

30. **Bandyukova, V.A., G.N. Zemtsova, N.V. Sergeeva, and V.I. Frolova, 1970.** Khim. Prir. Soedin., 6(3): 388.
31. **Barrero, A.L., J.F. Sanchez, and I. Rodriguez, 1989.** Phytochem., 28(7): 1975-1976.
32. **Bohlmann, F., and H. Jastrow, 1962.** Ber., 95: 2939-2944
33. **Bohlmann, F., and U. Hinz, 1964.** Ber., 97(2): 520-522.
34. **Bohlmann, F., U. Hinz, A. Seyberlich, and J. Repplinger, 1964.** Ber., 97(3): 809-814.
35. **Bohlmann, F., K.M. Rode, and C. Zdero, 1966.** Chem. Ber., 99(11): 3544-3551.
36. **Bohlmann, F. and H. Moench, 1967.** Chem. Ber., 100(6): 1944-1948.
37. **Bohlmann, F., C. Zdero, and H. Bethke, 1966.** Chem. Ber., 100(8): 2523-2531.
38. **Bohlmann, F., and U. Niedballa, 1967.** Chem. Ber. 100(11): 3703-3705.
39. **Bohlmann, F., and C. Zdero, 1967.** Tetrahedron Lett., (33): 3239-3242.
40. **Bohlmann, F., M. Wotschokowsky, J. Laser, C. Zdero, and K.D., Bach, 1968.** Chem. Ber., 101(6): 2056-2061.
41. **Bohlmann, F., and J. Laser, 1970.** Chem. Ber., 103(7): 2100-2104.
42. **Bohlmann, F., W. Skuballa, C. Zdero, T. Kuehle, and P. Steirl, 1971.** Justus Liebigs Ann. Chem., 745: 176-192.
43. **Bohlmann, F., and C. Zdero, 1973.** Chem. Ber., 106(7): 2140-2143.
44. **Bohlmann, F., and R.K. Gupta, 1981.** Phytochem., 20(12): 2773-2775.
45. **Breton, J.L., A.G. Gonzalez, and S.O., Ruiz, 1967.** An. Real Soc. Espan. Fis. Quim., Ser. B 63(6): 703-710.
46. **Breton, J.L., B. M. Garcia and A.G. Gonzalez, 1968.** An. Quim., 64(2): 187-192.
47. **Breton, J.L., A.G. Gonzalez, and M.R. Rodriguez, 1969.** An. Quim., 65(3): 297-301.
48. **Bruno, M., and W. Herz, 1988.** Phytochem., 27(6): 1873-1875.
49. **Buttery, R.G., D.M. Maddox, D.M. Light, and L.C. Ling, 1986.** J. Agric. Food. Chem., 34: 786-788.
50. **Cassady, J.M., and G.C. Hokanson, 1978.** Phytochem., 17: 324-325.
51. **Cassady, J.M., D. Ambramson, P. Cowall, C. Chang, and J.L. McLaughlin, J.L., 1979.** J. Nat. Prod., 42(4): 427-429.
52. **Cassady, J.M., M.F. Bean, J.L. McLaughlin, and Aynelachi, 1984.** Experientia, 40: 930-931.
53. **Collado, I.G., F.A. Macias, G.M. Massanet, and F.R. Lius, 1985.** J. Nat. Prod., 48(5): 819-822.
54. **Collado, I.G., F.A. Macias, G.M. Massanet, and F.R. Lius, 1985.** Phytochem., 24(9): 2107-2109.
55. **Collado, I.G., F.A. Macias, G.M. Massanet, and F.R. Lius, 1986.** Rev. Latinoam. Quim., 16(4): 128-141.
56. **Collado, G.I., F.A. Macias, G.M. Massanet, and F.R. Lius, 1986.** Tetrahedron lett., 42(13): 3611-3622.
57. **Cowall, P.L., 1981.** Dessertation Abstract Int., 42(01), 226-B.
58. **Dominguez, X.A., M. Gutierrez, and N. Armenta, 1969.** Planta Med., 18(1): 51-54.
59. **Dominguez, X.A., L.A. Gonzalez, and P. Rojas, 1972.** Phytochem., 11: 850-1.
60. **Drozdz, B., 1966.** Diss. Pharm. Pharmacol., 18(3): 281-283.
61. **Drozdz, B., 1967.** Diss. Pharm. Pharmacol., 19(2): 223-225.
62. **Drozdz, B., 1968.** Diss. Pharm. Pharmacol., 20(1): 93-103.
63. **El-Dahmy, S., F. Bohlmann, T.M. Sarg, A. Ateya, and N. Farrag, 1985.** Planta Med., (2): 176-177.
64. **El-Emary, N.A., Y. Kobayashi, and Y. Ogihara, 1983.** Fitoterapia 54(3): 133-134.
65. **El-Masry, S., F.A. Darwish, A. Abou-Donia, M.A. Abou-Karam, and M. Grenz, 1985.** Phytochem., 24(5): 999-1001.
66. **Evstratova, R.I., K.S. Rybalko, and V.I. Sheichenko, 1972.** Khim. Prir. Soedin., 8(4): 451-461.
67. **Evstratova, R.I., V.I. Sheichenko, and K.S. Rybalko, 1973.** Khim. Prir. Soedin. (2): 161-167.
68. **Farkas, L., L. Hoerhammer, H. Wagner, H. Roesler, and R. Grniak, 1964.** Magy. Kem. Folyoirat, 70(7): 310-312.
69. **Fernandez, I., B. Garcia, F.J. Grancha, and J.R. Pedro, 1987.** Phytochem., 26(8): 2403-2405.
70. **Ferreres, F., and F. Tomas, 1980.** An. Quim., Ser. C, 76(1): 92-93.
71. **Ferreres, F., and F. Tomas, 1980.** Bull. Liaison-Groupe polyphenols, (9): 294-301.
72. **Ferreres, F., F. Tomas, A. Guirado, and F.A. Tomas, 1980.** Afinidad, 37(368): 337-338.
73. **Gadeschi, E., Z.D. Jorge, G.M. Massanet, and F.R. Luis, 1989.** Phytochem., 28(8): 2204-2206.
74. **Gavina, F., J. Delgado, M. Gonzalbes, and E. Villar, 1974.** Quim. 70(12): 1035-1036.
75. **Gonzalez, A.G., J. Bermejo, J.L. Breton, and J. Triana, 1971.** An. Quim, 67(8): 795-799.
76. **Gonzalez, A.G., J.M. Arteagea, J. Bermejo, and J.L. Breton, 1971.** An Quin, 67(12): 1243-1244.
77. **Gonzalez, A.G., J. Bermejo, J.L. Breton, and J. Triana, 1972.** Tetrahedron Lett., 20: 2017-2020.
78. **Gonzalez, A.G., J. Bermejo, and M.R. Rincones, 1972.** Quinica, 68(3): 333-334.
79. **Gonzalez, A.G., J. Bermejo, J.L. Breton, and R.M. Rodriguez, 1973.** An. Quin, 69(6): 801-803.
80. **Gonzalez, A.G., J.M. Arteaga, and J.L. Breton, 1973.** Phytochem., 12: 2997-2999.
81. **Gonzalez, A.G., J. Bermejo, I. Cabrera, and G.M. Massanet, 1974.** An. Quim, 70(1): 74-75.
82. **Gonzalez, A.G., J. Bermejo, J.L. Breton, G.M. Massanet, and J. Triana, 1974.** Phytochem., 13: 1193-1197.
83. **Gonzalez, A.G., J.M. Arteaga, and J.L. Breton, 1975.** Phytochem., 14: 2039-2041.
84. **Gonzalez, A.G., J. Bermejo, J.L. Breton, G.M. Massanet, B. Dominguez, and J.M. Amaro, 1976.** S. C. S. Perkin I, 1663-1666.
85. **Gonzalez, A.G., J. Bermejo, I. Cabrera, A. Galindo, and G.M. Massanet, 1977.** An. Quim, 73: 86-87.
86. **Gonzalez, A.G., J. Bermejo, and G.M. Massanet, 1977.** Rev. Lat. Quim, 8: 176-180.
87. **Gonzalez, A.G., J. Bermejo, J.M. Amaro, G.M. Massanet, Galindo, A., and I. Cabrera, 1978.** Can. J. Chem., 56(4): 491-944.
88. **Gonzalez, A.G., J. Bermejo, I. Cabrera, G.M. Massanet, H. Mansilla, and A. Galindo, 1978.** Phytochem., 12: 955-956.
89. **Gonzalez, A.G., J. Bermejo, T. Zaragoza, and R. Velazquez, 1980.** An. Quim, Ser. C, 76(3): 296-297.
90. **Gonzalez, A.G., V. Darias, G. Alonso, and E. Estevez, 1980.** Planta Med., 40(2): 179-184.
91. **Gonzalez, A.G., J. Bermejo, F. Toledo, and L.R. Daza, 1981.** Phytochem., 20(8): 1895-1897.
92. **Gonzalez, A.G., A.D. De La Rosa, and G.M. Massanet, 1982.** Phytochem., 21(4): 895-897.
93. **Gonzalez, A.G., J.M. Velanzquez, and J.L. Breton, 1983.** An. Quim, 79(C): 469-470.

94. **Gonzalez, A.G., J.B. Barrera, T.Z. Garcia, and F.E. Rosas, 1984.** Phytochem., 23(9): 2071-2072.
95. **Hodisan, V., M. Tamas, and I. Mester, 1985.** Clujul Med., 58(4): 378-381.
96. **Huneck, S., J. Jakupovic, and A. Schuster, 1986.** Planta Med., 398-399.
97. **Jakupovic, J., Y. Jai, V.P. Pathak, F. Bohlmann, and R.M. King, 1986.** Planta Med., 5: 399-401.
98. **Jente, R.,1971.** Tetrahedron Lett. 27(17): 4077-4083.
99. **Jente, R., F. Bohlmann, and S. Schoneweiss, 1979.** Phytochem., 18: 829-837.
100. **Kagegawa, K., Y. Kaneko, E. Hattori, K. Kioke, and K. Takeda, 1987.** Phytochem., 26(8): 2261-2263.
101. **Kamanzi, K., and J. Raynaud, 1977.** Plant, Med. Phytother., 11(4): 289-293.
102. **Kamanzi, K., J. Raynaud, and B. Voirin, 1982.** Pharmazie, 37(6): 454-455.
103. **Kamanzi, K., J. Raynaud, and B. Voirin, 1982.** Pharmazie, 37(7): 523.
104. **Kamanzi, K., J. Raynaud, and B. Voirin, 1982.** Plant, Med. Phytother., 16(1): 30-33.
105. **Kamanzi, K., J. Raynaud, and B. Voirin, 1983.** Plant, Med. Phytother., 17(1): 47-51.
106. **Kamanzi, K., B. Voirin, and J. Raynaud, 1983.** Plant, Med. Phytother., 17(1): 52-56.
107. **Kamanzi, K., J. Raynaud, and B. Voirin, 1983.** Plant, Med. Phytother., 17(1): 57-60.
108. **Kamanzi, K., J. Raynaud, and B. Voirin, 1983.** Pharmazie, 38(7): 494-495.
109. **Karawya, M.S., S.H. Hilal, M.S. Hifnawy, and S.S. El-Hawary, 1977.** Egypt. J. Pharm. Sci., 16(4): 445-455.
110. **Kery, A., H.A.A. Tawaij, and N.K. Al-Kazraji, 1985.** Herba. Hung., 24(2-3): 183-194.
111. **Kesley, R.G. and L.J. Locken, 1987.** J. Chem. Ecol., 13(1): 19-33.
112. **Khalmatuv, Kh.Kh. and Kh. Aliev, 1966.** Tr. Tashkent. Farmatsevt. Inst., 4: 24-27.
113. **Kondratyuk, E.N., D.S. Ivashin, and A.P. Ivashina, 1974.** Ukr. Bot. Zh., 31(6): 786-92.
114. **Kowalewski, Z., H. Gerting, and M. Berlik, 1966.** Poznan. Tow. Przyjaciol. Nauk, Wyd. Lek., Pr. Kom. Farm., 5: 65-70.
115. **Kurmaz, B.V., 1962.** Farmatry et. Zh., 17(2): 40-44.
116a. **Kurmaz, B.V., O.K. Bagrii, A.M. Borisenko, and P.A. Yuzbashinskaya, 1968.** Farm. Zh., 23(3): 73-76.
116b. **Kuzovkas, A.D., P.S. Massagetov, and R.I. Bogmazova, 1953.** Zhur, Obscher Khim., 23: 157.
117. **Lago, M., and J. Luis, 1980.** Circ. Farm., 38,(267): 217-230.
118. **Lobo, J.M.V., and A.C. Puig.** Chem. Abs. 89: 11236b.
119. **Locken, L.J. and R.G. Kelsey, 1987.** Bio. Syst. Ecol., 15(3): 313-320.
120. **Lofgren, N., and L. Johansson, 1963.** Acta Chem. Scand., 17(4): 1065-1076.
121. **Mahmoud, Z.F., F.F. Kasem, and N.A. Abdel Salam, 1986.** Egypt. J. Pharm. Sci., 27(1-4): 283-289.
122. **Mansour, R.M.A., M.F. Abdalla, and N.A.M. Saleh, 1988.** Bull. Chem. Soc. Ethiop., 2(1): 45-46.
123. **Mason, J.H., A.T. Hewson, O. Kennard, and R.C. Pettersen, 1972.** J.C.S. Chem. Comm., 460-461.
124. **Massanet, G.M., I.G. Collado, and F.A. Macias, 1983.** Tetrehedron Lett., 24(15): 1641-1642.
125. **Massiot, G., A.M. Morfaux, L. Le Men-Olivier, J. Bouquant, A. Madaci, A. Mahmoud, M. Chopova, and P. Aclinou, 1986.** Phytochem., 25(1): 258-261.
126. **Masso, J.L., M.N. Bertran, and T. Adzet, 1979.** Plant, Med. Phytother., 13(1): 41-45.
127. **Merrill, G.B., and K.L. Stevens, 1985.** Phytochem., 24(9): 2013-2017.
128. **Milkova, Ts., N. Marekov, K. Hobert, and P. Welzel, 1986.** Izv. Khim, 19(3): 416-421.
129. **Monea, M., and A. Radu, 1979.** Rev. Med., 25(1-2): 103-105.
130. **Monya, M., 1971.** Farmacia, 19(1): 45-50.
131. **Mukhametzhanov, M.N. A.I. Shreter, and D. Pakalns, 1969.** Khim. Prir. Soedin. 5(6): 590-591.
132. **Muraveva, D.A. and V.N. Bubenchikova, 1986.** Khim. Prir. Soedin, (1): 107-108.
133. **Naydenova, E.I., I. Kolarova-Pavlova, D.V. Popov, S. Dimitrova-Konaklieva, and L. Dryanovska-Noninska, 1988.** Comples Rendus De L'Academie Bulgare Des Sciences, 41(4): 105-106.
134. **Negrete, R.E., N. Backhouse, B. Bravo, S. Erazo, R. Garcia, and S. Avendano, 1987.** Plant, Med. Phytother., 21(2): 168-172.
135. **Negrete, R.E., N. Backhouse, and A. San Martin, 1988.** Chemiker-Zeitung, 112(4): 144-146.
136. **Negrete, R.E., I. Latorre, N. Backhouse, R. Pena, and C. Delporte, 1988.** Plant Med. Phytother., 22(1): 1-10.
137. **Nowak, G., B. Drozdz, W. Kroszczynski, and M. Holub, 1986.** Acta Soc. Bot. Pol., 55(1): 17-22.
138. **Nowak, G., B. Drozdz, M. Holub, M. Budesinsky, and D. Siman, 1986.** Acta Soc. Bot. Pol., 55(2): 227-231.
139. **Nowak, G., B. Drozdz, M. Holub, and A. Lagodzinska, 1986.** Acta. Bot. Pol., 55(4): 629-237.
140. **Ohino, N., H. Hirai, and H. Yoshioka, 1973.** Phytochem., 12: 221-222.
141. **Oksuz, S., A. Ulubelen, Y. Aynechi, and H. Wagner, 1982.** Phytochem., 21(11): 2747-2749.
142. **Oksuz, S., and E. Putun, 1983.** Phytochem., 22(11): 2615-1616.
143. **Oksuz, S., H. Ayyildiz, and C. Johansson, 1984.** J. Nat. Prod., 47(5): 902-903.
144. **Oksuz, S., and H. Ayyildiz, 1986.** Phytochem., 25(2): 535-538.
145. **Oksuz, Sevil, and Ersan, Putun, 1987.** Doga: Kim. Ser., 11(2): 66-71.
146. **Oksuz, S., B. Halfon, and B. Terem, 1988.** Planta Med., 54(1): 89.
147. **Panosyan, A.G., 1976.** Tezisg Dokl-Molodehnaya Konf. Org. Sint. Bioorg. Khim., 58.
148. **Parareda, S.I., S.J. Parareda, and J.M. Viguera, 1968.** An. Chim., 64(6): 633-636.
149. **Picher, M.T., E. Seone, and A. Tortajada, 1984.** Phytochem, 23(9): 1995-1998.
150. **Picher, M.T., E. Seoane, and A. Tortajada, 1984.** Phytochem., 23(12): 2956-2958.
151. **Picher, M.T., E. Seoane, and A. Tortajada, 1985.** An. Quim. Ser. C., 81(3): 211-213.
152. **Picher, M.T., E. Seoane, and A. Tortajada, 1987.** J. Nat. Prod., 47: 184-185.
153. **Plouvier, V., 1970.** C. R. Acad. Sci., Ser. D., 270(22): 2710-2713.
154. **Rasulov, F.A., Sh. A. Ibragimov, and M.B. Belyi, 1983.** Khim, Prir. Soedin, (4): 524-525.

155. **Revazova, L.V., M.I. Eribekyan, and V.A. Mnatsakanyan, 1973.** Arm. Khim. Zh., 26(9): 775-780.
156. **Rizk, A.M., F.M. Hammouda, and S.I. Ismail, 1972.** Experientia, 28(7): 778.
157. **Rosler, H., A.E. Star, and T.J. Mabry, 1971.** Phytochem., 10(2): 450-451.
158. **Rustaiyan, A., A. Niknejad, C. Zdero, and F. Bohlmann, 1981.** Phytochem., 20(10): 2427-2429.
159. **Rustaiyan, A., A. Sharif, A. Tajarodi, J. Ziesche, and F. Bohlmann, 1984.** Planta Med., 50(2): 193-194.
160. **Rustaiyan, A., and S. Ardebili, 1984.** Planta Med., 50(4): 363-364.
161. **Rustaiyan, A., A. Niknejad, and Y. Aynehchi, 1985.** Planta Med., 44(3): 185-186.
162. **Saito, N., K. Hirata, R. Hotta, and K. Hayashi, 1964.** Proc. Jap. Acad., 40(7): 516-521.
163. **Sakakibara, J. N. Shirai, N. Ishida, and M. Yasue, 1977.** Nagoya-shiritsu Daigaku Yakugakubu Kenkyu Mempo, 25: 29-33.
164. **Saleh, M.R.I., and S. Gharbo, 1963.** J. Pharm. Sci. U. Arab. Rep., 4: 17-23.
165. **Sarg, T.M., M. El-Domiaty, and S. El-Dahmy, 1987.** Sci. Pharm., 55: 107-110.
166. **Sarg, T., S. El-Dahmy, M. El-Domiaty, and A. Ateya, 1988.** Acta Pharm. Hung., 58: 129-134.
167. **Sepulveda-Boza, S., and E. Breitmaier, 1987.** Chemiker-Zeitung, 111(6): 187-191.
168. **Stevens, K.L., 1982.** Phytochem, 21(5): 1093-1098.
169. **Stevens, K.L., and G.B. Merrill, 1984.** "The Chemistry of Alleopathy", pp 84-98.
170. **Stevens, K.L., 1986.** J. Chem. Eco., 12(6): 1205-1211.
171. **Stevens, K.L., and R.Y. Wong, 1986.** J. Nat. Prod., 49(5): 833-837.
172. **Stoyanov, N., P. Savchec, Zh. Stefanov, 1972.** Tr. Nauch-noizsled Khim.-Farm. Inst., 7: 189-198.
173. **Suchy, M. and V. Herout, 1962.** Coll. Czech. Chem. Commun., 27: 1510-1512.
174. **Suchy, M., V. Herout, and F. Sorm, 1965.** Coll. Czech. Chem. Commun., 30(8): 2863-2864.
175. **Sulyok, G., and A. Lazzlo-Bencsik, 1985.** Phytochem., 24(5): 1121-1122.
176. **Takeda, K., and S. Tominaga, 1983.** Bot. Mag. Tokyo, 96: 359-363.
177. **Takeda, K., C. Kumegawa, J.B. Harborne, and R. Self, 1988.** Phytochem., 27(4): 1228-1229.
178. **Tamura, H., T. Kondo, Y. Kato, and T. Goto, 1983.** Tetrahedron Lett., 24(51): 5749-5752.
179. **Tarasov, V.A., Sh. Z. Kasymov, G.P. Sidyakin, 1973.** Khim. Prir, Soedin., 9(3): 437.
180. **Thiessen, W.E., H. Hope, N. Zarghami, D.E. Heinz, P. Deuel, and E.A. Hahn, 1969.** Chem. Ind., 460-461.
181. **Tortajada, A., M.T. Picher, M.M. Reventos, and J.M. Amigo, 1988.** Phytochem., 27(11): 3549-3550.
182. **Tsukida, K., and M. Yokota, 1964.** Bitamin, 30(1): 9-12.
183. **Tsankova, E., and I. Ognyanov, 1985.** Planta Med., 465-466.
184. **Twaij, H.A.A., A. Kery, and N.K. Al-Khazraji, 1983.** J. Ethnopharmacol., 9(2-3): 299-314.
185. **Ulubelen, A., S. Oksuz, 1982.** J. Nat. Prod., 45(3): 373.
186. **Ulubelen, A., S. Oksuz, and A.H. Mercili, 1988.** Phytochem., 27(12): 3964-3965.
187. **Upadhyaya, K.M. 1986.** Can. J. Bot. 64, 2428-2432.
188. **Villar, A., and M. Paya, 1985.** Planta Med. Phytother., 19(1): 4-10.
189. **Wagner, H., L. Hoerhammer, R. Hoer, T. Murakami, and L. Farkas, 1969.** Tetrahedron Lett., (39): 3411-1414.
190. **Wagner, H., R. Hoer, T. Murakami, and L. Farkas, 1973.** Chem. Ber., 106(1): 20-27.
191. **Zarghami, N., and D.E. Heinz, 1969.** Chem. Ind., 1556-1557.