POLLEN ANALYSIS OF WINTER HONEY SAMPLES FROM MAINPURI DISTRICT OF UTTAR PRADESH

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Quantitative and qualitative analysis of twenty apiary honey samples of *Apis mellifera,* collected during November-2004 to January-2006, from three different places of Mainpuri District has been made to determine the pollen frequencies and also to ascertain the composition of honey in the area. All winter honey samples studied were visually light yellow in color predominated by pollen of *Brassica nigra* (41-87%) which made the honey as unifloral. *Ricinus communis* and *Eucalyptus hybrida* were found as secondary pollen in few samples and made them as multifloral. In others these were present as important minor pollen types. The minor pollen types of winter honey samples include *Sesamum indicum, Convolvulus microphyllus, Trianthema portulacastrum, Ziziphus jujuba, Capsicum annuum, Acacia nilotica, Coriandrum sativum, Chenopodium album, Prosopis juliflora, Ocimum sanctum, Abutilon indicum, Leucas aspera, Hibiscus rosa-sinensis, Lindenbergia indica, Cucurbita maxima, Xanthium strumarium, Lowsonia inermis, Rungia repens* and *Tribulus terrestris.* Out of the total 27 families, 24 of dicots represented by 39 genera and 3 of monocots represented by 6 genera were found in the winter honey samples.

Keywords: *Apis mellifera*; Bee forage plants; Nectar; Pollen.

Introduction

The "Mellissopalynology" deals with the quantitative and qualitative study of pollen grains in honey. It reveals not only the purity but also the diversity of nectar and pollen producing flora of a particular locality which are beneficial for honey bees and the beekeepers. Determination of botanical and geographical origin of honey was judged by several workers[1-3]. Pollen analysis of honey and also been done for nectar and only pollen producing plants[4-17]. Bee forage is an important aspect for abundant bee keeping. The Mainpuri is a backward district which has tremendous scope of bee keeping by which the economy of this region can be enhanced. Keeping this view in mind this study was undertaken at three different sites namely Singhpur, Gaziapur and Naviganj which are nearly 20-30 km away from each other.

Material and Methods

Eigteen apiary honey samples of *Apis mellifera* L. (measuring 100ml each) have been collected from three different selected sites of Mainpuri district during the period from November 2004 January 2006 (two samples of each month). The methodology recommended by the International Commision for Bee Botany[18] was employed for the recovery and analysis of the pollen contents from the honey samples. Slide preparation and their observation were made after the standard techniques[18-19]. The pollen types were placed in 4 frequency classes viz., predominant pollen type (>45 % of the total pollen complement of nectariferous taxa), secondary pollen type (16-45 %), important minor pollen type (3-15 %) and minor pollentype (< 3 %). The honey were designated as unifloral if they contained a predominant pollen type and multifloral, otherwise.

The ratio of honey dew elements *i.e.,* fungal spores and hyphae, algae and wax particles total number of pollen grains of nectariferous taxa in each sample (HDE/P) was obtained by the study of unacetolysed honeys. The absolute pollen count (APC) of the honey samples i.e., the number pollen grains per 10 gm of honey were calculated[18]. The samples were categorized under various groups in conformity with the universally followed grading parameters[19].

A frequency distribution (frequency of occurrence) of pollen types was determined from the total complement of honey samples and 4 discrete classes were recognized viz., very frequent (present in more than 50 % of the samples), frequent (20-50 %), infrequent (10-20 %) and rare (less than 10%)[20]. Counting of pollen grains in a pollen load were also done and interpreted[21].

Table 1. Inventory and pollen characterization of winter honey.

Honey Samples Collection	Month & Year	Colour	APC (Absolute Pollen Count /10 gm of honey	HDE/P	Group	Nature of Honey
SH-11 (Singhpur)	Nov.2004	light yellow	5,31,676	0.01	Gr.-IV	Unifloral
GH-11 (Gaziapur)	Nov.2004	light yellow	5,53,456	0.006	Gr.-IV	Unifloral
NH-11 (Naviganj)	Nov. 2004	light yellow	8,85,520	0.01	Gr.- IV	Unifloral
SH-12 (Singhpur)	Dec. 2004	light yellow	6,46,956	0.008	Gr.- IV	Unifloral
GH-12 (Gaziapur)	Dec. 2004	light yellow	7,52,709	0.008	Gr.- IV	Unifloral
NH-12 (Naviganj)	Dec. 2004	light yellow	10,84,780	0.02	Gr. - II	Unifloral
SH-1 (Singhpur)	Jan. 2005	light yellow	1,01,836	0.007	Gr.- III	Unifloral
GH-1 (Gaziapur)	Jan. 2005	light yellow	2,46,869	0.007	Gr.- III	Multifloral
NH-1 (Naviganj)	Jan. 2005	light yellow	2,79,809	0.04	Gr.- III	Unifloral
Average	SH (499,751), GH (5,45,597) and NH (6,56,927)					

Results and Discussion

In the present study a critical pollen content analysis of honey collected from three selected sites viz. Singhpur, Gaziapur and Naviganj during winter has been done and described on the basis of frequency classes, frequency percentage of pollen type at individual site. Overall relative frequency percentage, frequency occurrence, Maurizio groupings and similarity indices of different honey samples were also observed and represented in the form of Tables 1-3 and Fig.1.

Site I. Singhpur (SH-11, SH-12, SH-1)- At this site all the six honey samples were visually light yellow in colour and predominated by pollen of *Brassica nigra* which made the honey as "unifloral". Maximum percentage of *Brassica nigra* pollen (81.16%) was found in the month of December (SH-12) whereas its percentage was less in the months of November (68%) and January (53%). No pollen was recorded as secondary pollen type while important minor pollen types i.e. *Ricinus communis, Cajanus cajan, Psidium guajava, Arachis hypogaea, Eucalyptus hybrida,*

Trianthema portulacastrum and *Mangifera indica* and other minor pollen types were present in all the samples (Table 3). Absolute pollen count (APC) / 10 gm of honey was also observed high (6, 46,956) in the honey of December as compared to November and January (Table 1). Honey dew elements (HDE) i.e. fungal mycelium, spores were also seen. All the samples revealed unifloral nature of honey but on the basis of pollen number / 10 gm of honey the samples of November and December are placed in Maurizio group IV whereas the sample of January is placed in group III (Table 1).

Site II. Gaziapur (GH-11, GH-12, GH-1)- Six samples collected during November to January were of light yellow in colour. In these samples *Brassica nigra* pollen were found as predominant pollen type and their frequency was found maximum (65.85%) in the month of November whereas it was low in the month of December and January (47 - 48%). No secondary pollen type was recovered in the month of November whereas in December (GH-12)

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Table 2. Showing the names of the families, genera and species in the winter honey samples at different sites.

S.No	Family	Name of the plant
SITE 1. SINGHPUR-		
1.	ACANTHACEAE	*Hygrophila spinosa* T. And.
2.	AIZOACEAE	*Trianthema portulacastrum* L.
3.	AMARANTHACEAE	*Achyranthus aspera* L.
		Celosia argentea L.
4.	ANACARDIACEAE	*Mangifera indica* L.
5.	ASTERACEAE	*Ageratum conyzoides* L.
		Sonchus oleraceus L.
		Xanthium strumarium L.
6.	BRASSICACEAE	*Brassica nigra* L.
7.	CANNABINACEAE	*Cannabis sativa* L.
8.	CHENOPODIACEAE	*Chenopodium album* L.
9.	CONVOLVULACEAE	*Convolvulus microphyllus* L.
10.	CUCURBITACEAE	*Coccinia grandis* (L.) Voigt
		Cucurbita maxima Duch.
11.	CYPERACEAE	*Cyperus* sp. L.
12.	EUPHORBIACEAE	*Ricinus communis* Nees.
13.	FABACEAE	*Arachis hypogaea* L.
		Cajanus cajan L.
14.	LYTHRACEAE	*Lawsonia inermis* L.
15.	MIMOSACEAE	*Acacia nilotica* L.
16.	MYRTACEAE	*Eucalyptus hybrida* L.
		Psidium guajava L.
17.	OXALIDACEAE	*Oxalis corniculata* L.
18.	PEDALIACEAE	*Sesamum indicum* L.
19.	POACEAE	*Sorghum vulgare* L.
20.	UMBELLIFERAE	*Coriandrum sativum* L.
SITE 2. GAZIAPUR -		
1.	ACANTHACEAE	*Hygrophila spinosa* T. And.
		Rungia repens Nees.
2.	AIZOACEAE	*Trianthema portulacastrum* L.
3.	AMARANTHACEAE	*Achyranthus aspera* L.
		Celosia argentea L.
4.	ANACARDIACEAE	*Mangifera indica* L.
5.	ASTERACEAE	*Ageratum conyzoides* L.
		Tridex procumbens L.
		Xanthium strumarium L.
6.	BRASSICACEAE	*Brassica nigra* L.
7.	CAESALPINACEAE	*Cassia occidentails* L.
8.	CHENOPODIACEAE	*Chenopodium album* L.
10.	COMMELINACEAE	*Commelina forskalii* Vahl.
11.	CONVOLVULACEAE	*Convolvulus microphyllus* L.
12.	CUCURBITACEAE	*Luffa aegyptiaca* Mill
		Coccinia grandis (L.)Voigt.
		Cucurbita maxima Duch.

13.	CYPERACEAE	*Cyperus* sp. L.
14.	EUPHORBIACEAE	*Ricinus communis* L.
15.	FABACEAE	*Arachis hypogaea* L.
		Cajanus cajan (L.) Millsp.
		Indigofera linifolia Linnaee. Ali
16.	LABIATAE	*Leucas aspera* Spr.
17.	MALVACEAE	*Abutilon indicum* (L.) Sweet
		Hibiscus rosa-sinensis L.
18.	MIMOSACEAE	*Prosopis juliflora* (Sw.) DC
		Acacia nilotica L.
19.	MYRTACEAE	*Eucalyptus hybrida*
		Psidium guajava L. Willd. ex. Del
20.	OXALIDACEAE	*Oxalis corniculata* L.
21.	POACEAE	*Sorghum vulgare* Pers.
22.	RHAMNACEAE	*Ziziphus jujuba* (L.) Lam. non. Mill.
23.	SCROPHULARIACEAE	*Lindenbergia indica* (L.) Vatke.
24.	SOLANACEAE	*Capsicum annuum* L.
		Solanum nigrum L.
25.	UMBELLIFERAE	*Coriandrum sativum* L.
26.	ZYGOPHYLLACEAE	*Tribulus terrestris* L.

SITE 3. NAVIGANJ -

1.	AIZOACEAE	*Trianthema portulacastrum* L.
2	AMARANTHACEAE	*Achyranthus aspera* L.
3.	ANACARDIACEAE	*Mangifera indica* L.
4.	ASTERACEAE	*Ageratum conyzoides* L.
5.	BRASSICACEAE	*Brassica nigra* L.
6.	CANNABINACEAE	*Cannabis sativa* L.
7.	CHENOPODIACEAE	*Chenopodium album* L.
8.	CONVOLVULACEAE	*Convolvulus microphyllus* L.
9.	CUCURBITACEAE	*Coccinia grandis* (L.) Voigt
10.	CYPERACEAE	*Cyperus* sp. L.
11.	EUPHORBIACEAE	*Ricinus communis* L.
12.	FABACEAE	*Arachis hypogaea* L.
		Cajanus cajan (L.) Millsp
13.	LABIATAE	*Ocimum sanctum* L.
		Leucas aspera (Willd.) Spreng
14.	LYTHRACEAE	*Lawsonia inermis* L.
15.	MALVACEAE	*Abutilon indicum* L. Sweet
		Hibiscus rosa-sinensis L.
16.	MIMOSACEAE	*Acacia nilotica* (L.) Willd. ex. Del
17.	MYRTACEAE	*Callistemon citrinus* (Curtis) Skeels
		Eucalyptus hybrida L.
		Psidium guajava L.
18.	OXALIDACEAE	*Oxalis corniculata* L.
19.	PAPAVERACEAE	*Argemone maxicana* L.
20.	POACEAE	*Saccharum munja* Roxb.
		Sorghum vulgare Pers.
21.	SCROPHULARIACEAE	*Lindenbergia indica* (L.) Vatke
22.	SOLANACEAE	*Capsicum annuum* L.
		Solanum nigrum L.
23.	UMBELLIFERAE	*Coriandrum sativum* L.

Table 3. Average of frequency classes and frequencies (%) of pollen types recovered at different sites in different months of winter honey (November- January).

Months	Frequency Classes		Pollen type (%)
NOV.	P	-	*Brassica nigra* (64.98)
	S	-	Nil
	I	-	*Ricinus communis* (11.90), *Cajanus cajan* (7.22), *Eucalyptus hybrida*(3.63), *Psidium guajava* (3.38)
	M	-	*Arac* (1.28), *Tria* (0.92), *Conv* (0.89), *Cocci* (0.87), *Sesa* (0.83), *Cori* (0.62), *Acac* (0.51), *Zizi* (0.98), *Caps* (0.31), *Pros* (0.19), *Cheno* (0.18), *Hygr*, *Calli* (each 0.16), *Luffa* (0.11), *Xanth* (0.09), *Leuc* (0.08), *Ager*, *Trib* (each 0.07), *Osim*, *Abut* (each 0.60), *Hibi* (0.04), *Rung*, *Malv* (each 0.03) *Cucur*, *Laws*, *Lind* (each 0.02)
	NMP	-	*Sorghum vulgare* (0.58) *Achranthus aspera* (0.11), *Cypers* sp. (0.09), *Saccharum munja* (0.04)
DEC.	P	-	*Brassica nigra* (72.18)
	S	-	Nil
	I	-	*Eucalyptus hybrida* (9.99), *Arachis Hypogaea* (9.99), *Ricinus communis* (4.15)
	M	-	*Caja* (2.41), *Cocci* (1.15), *Psid* (1.0), *Conv* (0.78), *Acac* (0.72), *Oxal* (0.63), *Tria* (0.51), *Mang* (0.35), *Sesa* (0.31), *Caps* (0.23), *Ager*, *Comm* (each 0.09), *Luffa* (0.16), *Cori* (0.14), *Hygr*, *Pros* (each 0.09), *Trib*, *Abut* (0.07), *Cheno* (0.04), Rung, Leus, Calli (each 0.03), Cucur (0.02)
	NMP	-	*Sorghum vulgare* (0.33), *Achyranthus aspera*, (0.05), *Cyperus* sp.(0.02)
JAN	P	-	*Brassica nigra* (54.78)
	S	-	*Eucalyptus hybrida* (18.21)
	I	-	*Ricinus communis* (9.97), *Mangifera indica* (3.77), *Arachis hypogaea* (3.72)
	M	-	*Ager* (2.02), *Tria* (1.76), *Cheno* (1.14) *Cann* (0.75), *Cori* (0.66), *Conv*, *Caps*, each 0.48), *Cocci* (0.46), *Sola* (0.35), *Celo*, *Acac* (each 0.26), *Sonc* (0.23), *Oxal* (0.14), *Luffa* (0.11), *Abu* (0.06), *Trib*, *Caja* (each 0.05), *Cass*, *Arge* (each 0.03), *Leus*, *Indi* (each 0.02), *Calli* (0.01)
	NMP	-	*Cyperus* sp.(0.37), *Achyranthus aspera* (0.33)

P- Predominant pollen type (> 45 %); S- Secondary pollen type (16-45 %); I- Important minor pollen types (3-15 %); M- Minor pollen type (< 3 %); NMP- Pollen of non melliferous taxa.

Abbreviation for minor pollen type (< 3 %)

Abut- Abutilon indicum, Acac- Acacia nilotica, Ager- Ageratum conyzoides, Arac- Arachis hypogaea, Arge- Argemone maxicana, Bra- Brassica nigra, Caja- Cajanus cajan, Calli- Callistemone citrinus, Cann- Cannabis sativa, Caps- Capsicum annuum, Cass- Cassia occidentalis, Cheno- Chenopodium album, Cocci- Coccinia grandis, Comm- Commelina benghalensis, Conv- Convolvulus microphyllus, Cori- Coriandrum sativum, Cucur- Cucurbita maxima, Euca- Eucalyptus hybrida, Hibi- Hibiscus rosa-sinensis, Hygr- Hygrophila spinosa, Indi- Indigofera linifolia, Lind- Lindenbergia indica, Luffa- Luffa aegyptica, Laws- Lawsonia inermis, Mang- Mangifera indica, Malv- Malvastrum coromandelianum, Ocim- Ocimum sanctum, Oxal- Oxalis corniculata, Pros- Prosopis juliflora, Psid- Psidium guajava, Rici- Ricinus communis, Rung- Rungia repens, Sesa- Sesamum indicum, Sonc- Sonchus oleraceus, Sola- Solanum nigrum, Tria- Trianthema portulacastrum, Trib- Tribulus terrestris, Trid- Tridex procumbens, Xanth- Xanthium strumarium, Zizi- Ziziphus jujuba.
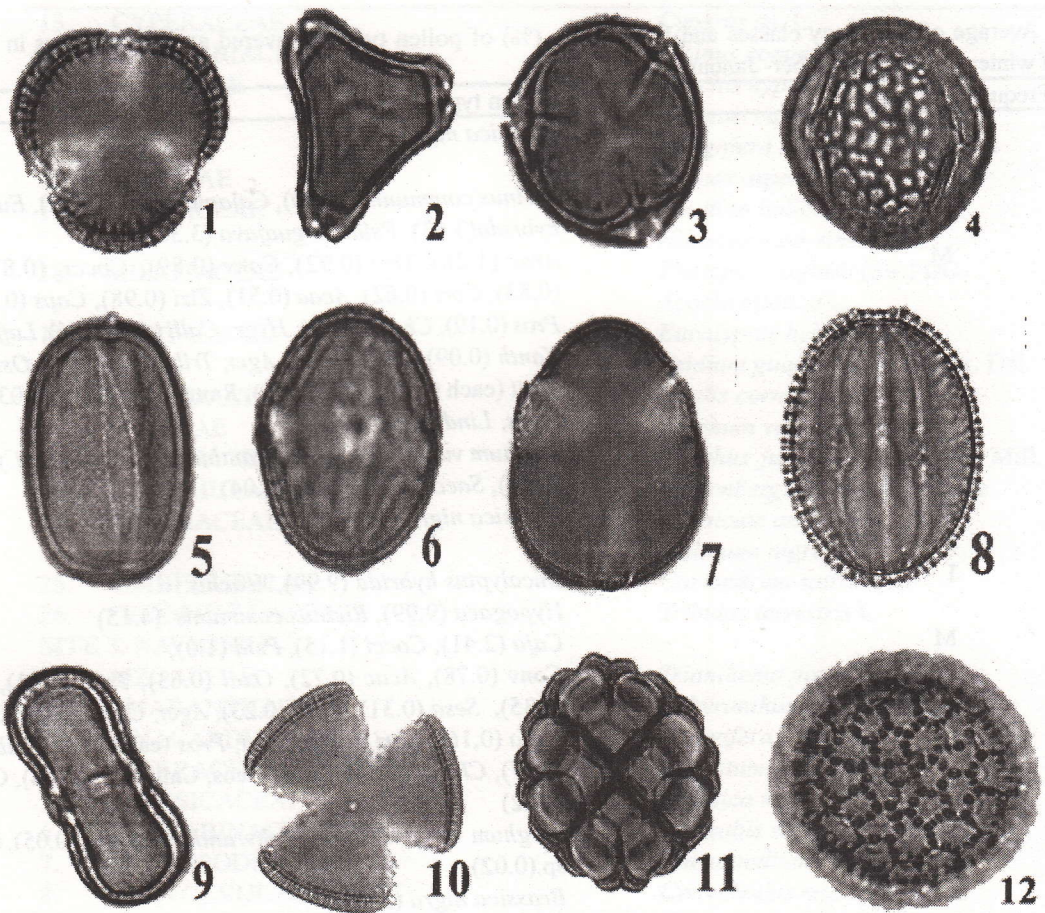
Fig.1.1. *Brassica nigra*; 2. *Eucalyptus hybrida*; 3. *Ricinus cmomunis*; 4. *Cajanus cajan*; 5. *Arachis hypogaea*; 6. *Mangifera indica*; 7. *Trianthema portulacastrum* 8. *Coccinia grandis*; 9. *Coriandrum sativum*; 10. *Convolvulus microphyllus*; 11. *Acacia nilotica*; 12. *Tribulus terrestris*.

and January (GH-1) *Eucalyptus hybrida* (23.68%) and *Ricinus communis* (16.05%) were recorded as secondary pollen types. Other important minor pollen types like *Arachis hypogaea*, *Cajanus cajan*, *Mangifera indica*, *Ageratum conyzoides* and *Coccinia grandis* along with other minor pollen types were recovered. Some non – melliferous pollen (NMP) types of *Sorghum vulgare*, *Achyranthus aspera*, *Cyperus* sp. were also found in the samples examined at this site. All the samples show single predominant pollen types of *Brassica nigra* forming unifloral honey. Absolute pollen count / 10 gm honey was observed high (7,52,709) in the month of December. HDE were also seen but these were in negligible amount (Table 1). Honey samples of November and December were categorized in Maurizio Group IV whereas honey of January as Group III.

Site III. Naviganj (NH-11, NH-12, NH-1) - All six samples examined at this site were also visually light yellow in colour and contained predominant pollen types of *Brassica nigra* whose frequency was maximum in the month of December (87%) as compared to the months of November and January (ranged 61 – 64 %). Thus the honey produced was of unifloral in nature. *Ricinus communis* and *Eucalyptus hybrida* were recovered as secondary pollen types in two months except December where these became important minor pollen types. Few pollen of *Sorghum vulgare*, *Saccharum munja*, and *Cyperus* sp. were also recovered as non - melliferous pollen types. The minor pollen types of winter honeys include *Sesamum indicum*, *Convolvulus microphyllus*, *Trianthema portulacastrum*, *Ziziphus jujuba*, *Capsicum annuum*, *Acacia nilotica*, *Coriandrum sativum*, *Chenopodium album*, *Prosopis juliflora*, *Callistemon citrinus*, *Ocimum sanctum*, *Abutilon indicum*, *Leucas aspera*, *Malvastrum coromendelianum*, *Luffa aegyptiaca*, *Hibiscus rosa-sinensis*, *Lindenbergia indica*, *Cucurbita maxima*, *Xanthium strumarium*,
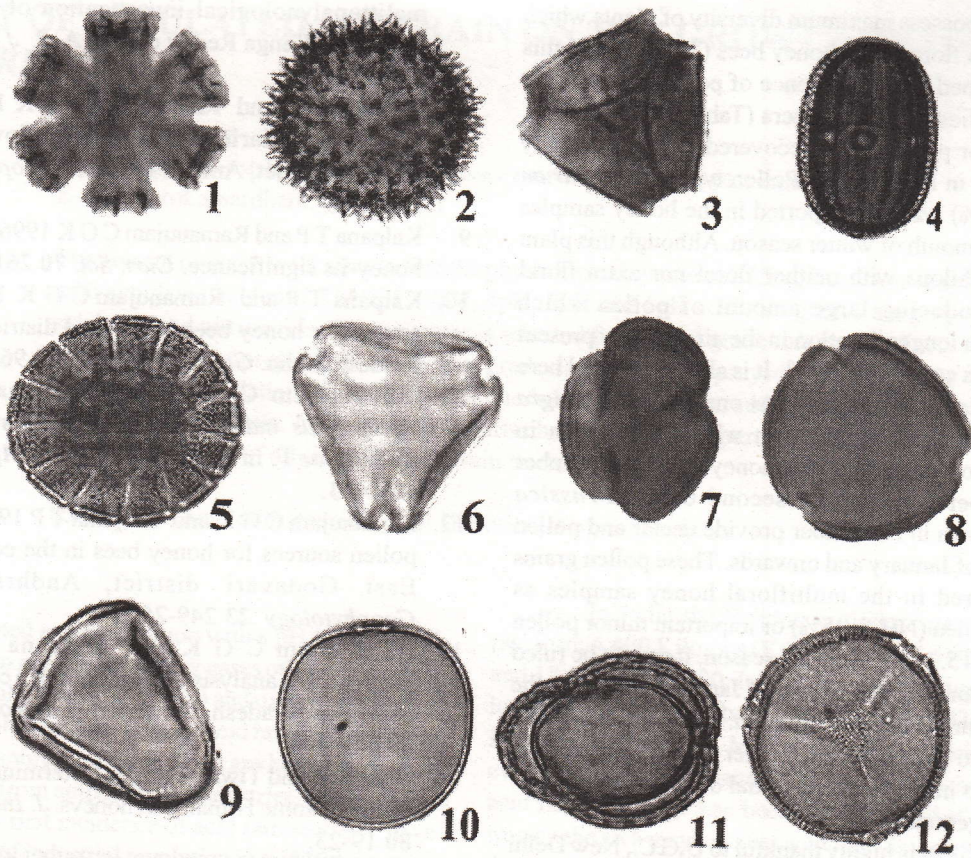
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Fig.2. 1. *Ocimum sanctum;* 2. *Malvastrum coromandelianum;* 3. *Callistemone citrinus;* 4. *Leucas aspera;* 5. *Sesamum indicum* 6. *Ziziphus jujuba* 7. *Lindenbergia indica;* 8. *Prosopis juliflora;* 9. *Cyperus sp.* 10. *Sorghum vulgare* 11. *Xanthium strumarium;* 12. *Luffa aegyptica.*
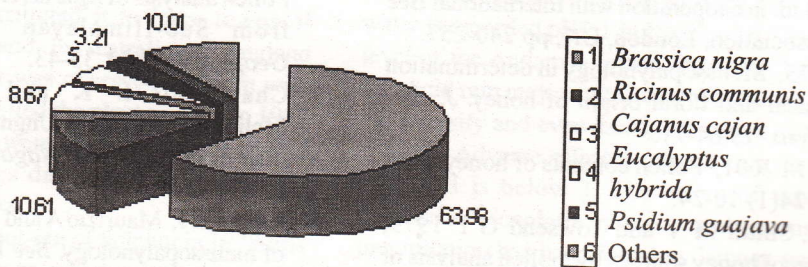

Fig. 3. Showing contribution of different plants in winter honey.

Hygrophila spinosa, Lowsonia inermis, Rungia repens and *Tribulus terrestris.* Honey dew elements indicators were scare or absent as the HDE /P ratio was = 0.02 in all the winter samples (Table 1). Absolute pollen count was observed high (10,84,780 /10 gm of honey) in the month of December whereas it was low in the month of November and January, respectively. On the basis of Absolute pollen count (APC) of all three samples of unifloral honey at this site were referable to Maurizio groups IV, V & III in November, December and January, respectively.

Honey collected during winter season contains maximum number of pollen in per 10 gm of honey. On an average absolute pollen count / 10 gm of honey was found minimum at Singhpur (4, 99,751), followed by Gaziapur (5, 45,597) and Naviganj (6,56,927). Therefore, it can be concluded that out of three sites, Naviganj site and its

surroundings possess maximum diversity of plants which provide pollen flora to the honey bees (Table 1) and this is also confirmed by the presence of pollen types of the different families and their genera (Table 2).

Major pollen types recovered during the study are illustrated in Fig.1 and 2. Pollen type of *Saccharum munja* (0.04 %) was also reported in the honey samples of November month of winter season. Although this plant is an anemophilous with neither floral nor extra floral nectaries, producing large amount of pollen which remained for a longer duration in the air and may present in the honey as contaminants[9-10]. It is also mentioned here that two species of *Brassica* – first one is *Brassica nigra* early variety of short duration which was sown in September provide nectar to the honey bees in November and December whereas the second one is *Brassica campestris* sown in November provide nectar and pollen in the month of January and onwards. These pollen grains were recovered in the multifloral honey samples as secondary pollen (NH-2-25%) or important minor pollen types (GH-2-15.34 %) of spring season. It cannot be ruled out that the honey in the month of January may have the pollen of both species of *Brassica*. Thus the more and more area is to be exploited for other melliferous crops in this district to improve the potential of beekeeping.

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