Review of Literature

REVIEW OF LITERATURE

M. charantia L. (bitter gourd) is an economically important species grown for its nutritious fruits esteemed as vegetable. Though, some work has been attempted on the improvement of bitter gourd, no concerted efforts has been made for the improvement of related taxa, domestication of wild species, collection of germplasm of wild species and their ethnobotany, propagation, genetic diversity, ecogeography and conservation.

2.1.Taxonomy and distribution

The taxonomic treatment of the genus *Momordica* is extensive. Generic and species descriptions along with keys are found to varying degrees in various floras published during pre independence period. Rheede's (1678) descriptions and illustrations of paval (= momordica) is the first printed record. Linneaus (1678), de Candolle (1828), Roxburgh (1832), Clarke (1879), Cooke (1908) Gamble (1919), Blatter (1919) and Kanjilal (1938) have dealt with the systematics of the genus extensively. During post-independence period, Santapau (1953), Saldhana (1976), Chakravarthy (1982) and Mathew (1981,1983) have treated the genera in their floristic works. Many of the regional and district floras also mentions and gives a small description of various *Momordica* species (Srivastava 1976, Oommachan 1977, Bhandari 1978, Naik 1979, Rao 1985, Shetty *et al.* 1987, Ramachandran and Nair 1988,Vajravelu 1990, Narasimhan and Sharma1991, Deshpande *et al.* 1993, Kothary and Murthy 1993, Chauhan *et al.* 1996, Sasidharan and Sivarajan 1996, Sivarajan and Mathew 1997, Pallithanam 2001, Singh *et al.* 2002 and Bhat 2003). Gamble (1919) mentions occurrence of *Momordica denudata* in Kerala from low country Quilon, which might have prompted Chakravarthy to mention its distribution in Kerala. Occurrence along with detailed technical description of *M. dioica* and *M. charantia* from Nallamalais (Ellis 1987) and Kurnool (Venkata Raju and Pulliah 1995) of Andhra Pradesh are reported. Saldhana (1976) gives detailed technical description along with key and occurrence of *M. charantia*, *M. dioica*, *M.*

subangulata and *M. cochinchinensis* from Karnataka. *Momordica subangulata* is reported as rare in semi evergreen and evergreen forests in Belgaum, Western Karnataka and *M. dioica* as frequent in wet forests of Western Ghats and Deccan. Rao (1985) reports *M. charantia* and *M. dioica* as fairly common in Goa. Detailed species descriptions and botanical accounts are dealt in various other publications (Anon. 1960). Trimmen (1895) has given a detailed technical description and key to the species of *Momordica* occurring in Sri Lanka. Backer and Brink (1963), Henderson (1974) and Keraudren (1975) have given detailed floristic account of *Momordica* species in other South East Asian countries. Oliver (1979) gives keys and detailed descriptions of the various African species of *Momordica.*

Chakravarthy's (1982) treatment of *Momordica* in Fascicles of Cucurbitaceae is the classification by far the most relied upon in India. He has enumerated seven species from India including *Momordica denudata* from Kerala and *Momordica macrophylla* from Assam-Manipur belt bordering Myanmar. He has also described a new variety, ie, *Momordica charantia* var. *muricata* based on Rheede's plate in *Hortus Malabaricus* as Type. Jeffrey (1980) rules out *Momordica subangulata* from India for the absence of ridged or longitudinally alate fruits and hence treat this component under *Momordica dioica*. de Wilde and Duyfjes (2002) gives a detailed taxonomic treatment of the genera in South and South East Asia. They have thoroughly revised the species concept and according to them *Momordica cochinchinensis* and *M. subangulata* do not occur in South India. A new sub specific rank in *M. subangulata* has been proposed which partially include *M. dioica* of North Eastern India. A considerable part of the taxa treated under *M. cochinchinensis* has been taken out and placed under *M. denticulata*. This study is of much interest as it covers all Indian species and the Malaysian taxa, which has affinity with North Eastern, Andaman and Western Ghat taxa. Pandey and Niraj Kumar (2002) also worked on the taxonomy and diversity of the genus in India. However, it does not vary substantially from that of

Chakravarthy (1982) and reports the same number of species and distribution in India.

2.2.Eco geographic studies

IPGRI sponsored Ecogeographic studies on the genepool of Hordeum (van Bothmer *et al.*, 1991), Phaseolus (Nabhan *et al.*, 1990), Vicia (Maxted *et al.* 1995) and Corchorus (Edmonds 1990) have been carried out. However, there are no reports on such studies in *Momordica* species. Rahman *et al.* (2001) reports germplasm collection of three accessions of *M. cochinchinensis* from Barak valley of Assam.

2.3.Indigenous Traditional Knowledge

Kirthikar and Basu (1933) have given detailed account of descriptions, key, vernacular name and medicinal and edible uses of *M. charantia*, *M. balsamina*, *M. dioica*, and *M. cochinchinensis*. Watt (1891) has given a detailed account of vernacular names in various Indian and South East Asian languages, habitat, cultivation and medicinal and food uses of *M. charantia*, *M. dioica*, and *M. cochinchinensis*. Yang and Walters (1992) gives a brief account of the uses of *M. charantia* and *M. cochinchinensis* in traditional Chinese medicine.

Yang and Walters (1992) have investigated the medicinal uses of *M. charantia* for rheumatism, gout, spleen and liver disorders, dysentery, anti pyretic agent, aphrodisiac and for the treatment of tooth aches. Rastogi and Mehrotra (1990) give structure and biological activity of the active principles of *M. charantia*. Yen and Hwang (1985) have proposed the use of red aril as an artificial food colourant. Uphof (1968) gives a small account of the economic importance of *M. charantia*, *M. subangulata*, *M. dioica*, and *M. cochinchinensis* in South East Asia and mentions the use of tender shoots, leaves and unripe fruits of *M. subangulata* as vegetable under the name 'Kambur' in Indonesia. A detailed account of the botany, distribution, chemistry and uses of various *Momordica* species in India is given in the Wealth of India (Anon. 1962). Morton (1967) and

Walters and Walters (1988) have given a good account of the botany, cultivation and uses of bitter gourd.

Reports of food uses of various wild *Momordica* species abound in floristic works involving Cucurbitaceae. Economic importance of bitter gourd in Mexico has been reviewed by Lira and Caballero (2002). The less known ethnomedicinal claims of anti-ulcerogenic effect of *M. charantia* in Turkish medicine (Gurbuz *et al.* 2000), abortifacient effects of *M. anguistisepala* in Nigerian folk medicine (Aguwa and Mittal 1983) and anti-inflamatory activities of *M. cochinchinensis* (Ng-T.B. *et al.* 1986) in China are interesting reports. Hypoglycemic effect of bitter gourd has been reported by many modern pharmaceutical and ethnobotanical studies (Athar *et. al.* 1981 and Day *et al.*, 1990). Kumbohojkar *et al.* (1999) reports medicinal uses of *M. dioica* tubers for snakebite and anti-fertility treatment by 'mahadeokoli' tribes in Western Ghats of Maharashtra. Gurdeva (2001) gives detailed account of vernacular names of various *Momordica* species in Malayalam, Tamil, Kannada, Telugu, Konkani, Marathi, Tulu, Hindi, Sanskrit and English. Many rare vernacular names of *Momordica* species, not reported elsewhere and prevalent in the local dialects across its distribution range, could be located.

2.4.Phenology

A great deal of information on the phenodynamics of trees has been generated through the works of Ashton (1969), Burgess (1972), Holmes (1942) and Koelmeyer (1954). However, the drawback associated with all these studies is that they are not based on systematic observations of the species throughout its range in the natural environment. Further, they are based solely on herbarium material. There are no reports on phenological studies in *Momordica* species.

2.5.Floral Biology

Floral biology of bitter gourd has been worked out by Pal *et al.* (1972) and Deshpande *et al.* (1979). Vahab (1993) has studied the floral biology of *M. dioica*

under Kerala conditions and rightly mentions evening anthesis in this taxa. Vijay *et al.* (1977) studied floral biology of kakrol under Coorg conditions, which he identifies as *M. cochinchinensis*. However, in the context of revelations of de Wilde (2002) as to the absence of *M. cochinchinensis* in south India and non-spotting of *M. cochinchinensis* collections from South India in Indian Herbaria, the true botanical status of this species needs to be verified. Patnaik and Patnaik (1976) studied the flowering, pollination, fruit set and development of *M. cochinchinensis* under Orissa conditions. Again as the binomials, common names and vernacular names have been used interchangeably for the members of the dioecious group, this again needs confirmation, as the cultivated teasle gourd is *M. subangulata* subsp. *renigera* and not true *M. cochinchinensis*. *M. balsamina*, *M. sahyadrica sp. nova* and *M. subangulata* subsp. *renigera* do not figure any where in the floral biology studies.

2.6.Insect pollinators

Insect pollinators of some cucurbits in Punjab including bitter gourd have been recorded by Grewal and Sidhu (1978). Halictids constituted over 60% of the pollinators; the megachilid bees visitation was occasional. Honeybees (*Apis mellifera*) are considered the principal pollinators of cucurbit vegetables including bitter gourd (Roubik 1995). Insect visitors of other *Momordica* species have been less recorded. Studies on pollinators of cucurbits are mainly centered around cucumbers, which has been worked out fairly well (Leppik and Verghese, 1977).

2.7.Fruit ripening

Biochemical changes associated with ripening in bitter gourd have been worked out by Xinping *et al.* (1999) and Rodrigues *et al.* (1976). A reduction in chlorophyll a & b content from colour breaker stage to gradual accumulation of carotenoids such as leutin and cryptoxanthin has been reported. Lycopene content of seed arils increased considerably imparting dark carmine colour.

2.8.Seed morphology

Chakravarthy and Hore (1979) have highlighted the importance of seed exomorphic traits in cucurbit classification at generic level. They have described 24 seed types including *M. charantia* and few other cultivated cucurbits.

2.9.Tuber and seed dormancy

In the dioecious *Momordica*, represented by sweet and spine gourd, dormancy of the seeds and tubers have been reported to be the main hindrance to its extension as a cultivated crop (Ram *et al.*, 2002). However, Ali *et al.* (1991) observed no dormancy in teasle gourd. Various physical and chemical methods have been used by many workers to break this dormancy with varying degrees of success. Panda *et al.* (1994) reports significant increase in tuber dormancy break by application of a 12 hr. dip in 1% Thio urea in the case of *M. dioica* dormant tubers.

Seed dormancy has been reported in sweet and spine gourd by many workers (Mishra and Sahoo, 1983; Mishra *et al.*, 1988 and Ram *et al.*, 2002). Seed coat removal and enhancing temperature of germination media was found effective in increasing emergence significantly in teasle gourd (Ali *et al.* 1991). Watanabe *et al.* (1988b) observed seed coat removal in effecting seedling emergence and attributed seed dormancy to hard seed coat and saponin inhibition, which upon seed coat removal is leeched out to a considerable extent. Bitter gourd, even though not having seed dormancy, a 12 h. soaking in 1% KNO_3 was reported to increase germination percentage considerably (Robinson and Walters 1997).

2.10.Vegetative Propagation

Even though bitter gourd is basically seed propagated, wedge grafting on *Luffa* had been in vogue in China and Taiwan for control of Fusarium wilt (ChungTa 1996). Compatability with 81.1% success and 38.4 % yield increase over non-grafted control was reported due to freedom from nematode and fusarium wilt

infection (Xi angBo 1998). Similarly, grafting of *Momordica dioica* on pumpkin has been reported successful (Mian and Morokuna, 1992 &1993). There are many reports on rooting of vine cuttings as a propagation technique in sweet gourd and spine gourd using various hormones (Mishra and Sahoo, 1983; Sahoo *et al.*, 1995; Tripathy *et al.*, 1993; Ali *et al.*, 1991and Ahmad *et al.*, 1992).

2.11.Package of Practices

A short and crisp but complete package of practice for bitter gourd was given by Peter *et al.* 1998. Detailed package of practices for other species of *Momordica* are yet to be worked out. However, Shadeque and Baruah (1984) and Mishra and Sahu (1983) gives a short account of the cultivation practices for sweet gourd, ie, *Momordica cochinchinensis*. Mishra *et al.* (1988), Tripathy *et al.* (1993), Fakir *et al.* (1992), Puzari (1997), Islam *et al.* (1994) and Ram *et al.* (2002) deals briefly about one or other aspects of cultivating spine gourd and sweet gourd. However, it is pertinent to note that the common names, sweet gourd and spine gourd and binomials vice versa, *Momordica dioica* and *M. cochinchinensis* are often used interchangeably in these articles and teasle gourd refers to *Momordica subangulata* subsp. *renigera*. The true wild forms, *M. dioica* and *M. sahyadrica*, often do not figure in these treatments. Mishra *et al.* (1986) gives hints to cultivation of *Momordica balsamina*. Begum *et al.* (1999) presents a small account of the package of practices recommended for teasle gourd cultivation in Bangladesh.

2.12.Numerical taxonomy

In the last three decades, there has been a swift growth of taxo-metric methods (numerical taxonomy) in biology. Sneath and his colleagues have contributed significantly in this field and there has been a considerable interchange of ideas with classical taxonomy. Considerable evidences for the application of Numerical taxonomy in biological sciences are abounding in literature. The review by Sneath and Sokal (1973) and Rohlf and Marcus (1993) give some glimpses about it.

Ray and Deka (2000) has conducted numerical taxonomic studies involving 10 mandarin orange collections from various Indian states using 65 morphological traits and calculated Euclidean distance, coefficient matrix and dendrograms to ascertain centers of origin. Pasha and Sen (1989) have carried out numerical taxonomic analysis of selected genera of cucurbits, but *Momordica* was represented by *M. charantia* var. *charantia* and *M. charantia* var. *muricata* only.

2.13.Interspecific Hybridization

Literature reference to interspecific hybridization in *Momordica* is scanty. Mohanty *et al.* (1994) attempted inter and intra specific hybridization between *M. dioica* and *M. cochinchinensis*. The F1 (CxD) vegetative and floral characters showed mostly intermediary and they have not observed much difference between male and female plants in the F1. Here again, the wrong botanical identity of *M. cochinchinensis* or teasle gourd is to be doubted from the descriptions of Assam kakrol. However, their experiment reveal the humid monsoon months as the best time for maximum fruit set. Even though they have given comparison of quantitative traits of F1 and parents including flower, no information about the fertility of the F1 hybrid and fruit set is given.

2.14.Biotic Stresses

Bacterial, fungal and viral diseases, nematodes and pests infesting bitter gourd and other cucurbits have been dealt in detail by Butani and Verma (1977), Robinson and Walters (1997) and Srinivasan and Pal (1998). In an on-farm study conducted at Thiruvanthapuram District, Kerala, *Hishimonas phycitus, Diaphania indica* and *Bactrocera cucurbitae* were found to be the major pests of bitter gourd (Nandakumar *et al.* 2003). Shadeque and Barua (1984), Mishra *et al.* (1988) and Ram *et al.* (2002) report fruit fly and epilacna beetle as major pests of *M. dioica* and *M. cochinchinensis*. However, no study of wild species of bitter gourd including *M. dioica* and *M. sahyadrica* was conducted in Kerala to ascertain their reaction to biotic stresses affecting bitter gourd.

2.15.Nutritive value.

Gopalan *et al.* (1982) gives detailed information on nutritive value of bitter gourd, sweet gourd and spine gourd. Estimation of lycopene from ripe bitter gourd fruits and its food application are given by Yen & Hwang (1985). Yield, nutritional value and keeping quality of teasle gourd have been worked out by Fakir *et al.* (1992). Variation in nutritional quality of seven *M. charantia* cultivars has been given by Jaiswal *et al.* (1990). Dubey and Gaur (1990) provides proximate analysis of four strains of kakrol. The chemical composition of *M. charantia* fruits has been worked out in detail by Yuwai *et al.* (1991). Changes in pigments in pulp and aril of bitter gourd during fruit ripening has been worked out by Xinping *et al.* (1999) which has much significance for antioxidant value of these group of plants.

2.16.Genetic erosion and threat status analysis

The only reference to threatened status of *Momordica* is given (Anon. 1997) in IUCN Red Data Book where *Momodica subangulata* Blume. from Wynad (Kerala) and South Canara (Karnataka) is accorded threatened-indeterminate status (taxa known to be extinct, endangered, vulnerable or rare but where there is not enough information to say which of the four categories is appropriate).

Momordica glabra Zimm., *M. Pycnantha* Harms. and *M. leiocarpa* Gilg., all from Tanzania, are other species grouped under the threatened category in the same report. The revised IUCN Red List Categories prepared by IUCN-Species Survival Commission (SSC) and approved at the 40th Meeting of the IUCN Council, Gland, Switzerland on 30th November, 1994 gives detailed categorization of threat status. Details of this can also be had from sources such as "How to use the IUCN Red data Book Categories" Threatened Plants Committee Secretariat, IUCN, Royal Botanical Garden, Kew, England. Ahmedullah and Nayar (1987) gives further details on extinction of species and concept of rarity.

Jha and Ujawane (2002) considers *Momordica balsamina* as nearing extinction in Saurashtra, Gujarath and *M. cochinchinensis* as endemic to Assam forests. Zuberi and Biswas (1998) reports *M. dioica* in Bangladesh in the endangered category. Dwivedi (1999) consideres *M. dioica* as endangered in Madhya Pradesh. However, these reports are based on assumptions and do not have the support of authentic field work.

2.17.Conservation strategies

Heywood (1998) gives a review of the importance of wild species for human welfare and emphasizes the significance of home gardens as a conservation option for semi domesticates and pre domesticates. References to conservation aspects of *Momordica* species are scanty. Bettencourt and Konopka (1990) has given a compilation of *ex situ* holdings of *Momordica* germplasm over the world. Mini Raj *et al.* (1993) gives conservation status of bitter gourd germplasm in National and International Gene banks. Ram and Srivastava (1999) reports collection of 519 accessions of bitter gourd germplasm by National Bureau of Plant Genetic Resources (NBPGR). Joshi (2002) reports maintenanace of 93 collections of *Momordica dioica* under AICRP on under utilitilized and under exploited plants whereas Ram *et al.* (2002) mentions 25 accessions of *M. cochinchinensis* as being field maintained at Assam Agricultural University,

Jorhat. Seeds of bitter gourd are reported to be cryo non-tolerant (Zhang *et al.*, 1990). Dubey and Gaur (1989) reports pollen viability in *M. dioica* up to 45 days at 3 oC and 0% RH. Thus, there is scope for conservation of pollen by extending the viability period.

Agelet *et al.* (2000), Bellon (1996), Louette *et al.* (1997), Lamont *et al.* (1999), Padouch & Jong (1999), Borthakur *et al.* (1999), Altieri *et al.* (1987), Altieri and Merrick (1987), Castineiras *et al.* (2000), Esquivel and Hammer (1992 a & b), Hodgkin (1995), Salazar (1996), Prain and Piniero (1995) and Landauer & Brazil (1990) have dealt with various aspects of homegardens in the conservation of biological diversity. An exhaustive bibliography of on-farm management of crop diversity has been presented by Long *et al.* (2000). Maxted *et al.* (2002) has come out with a generalized model for on-farm conservation of genetic diversity. Here they have provided a generalized methodological framework that can be applied by researchers to establish and implement an on-farm conservation project as part of an overall conservation strategy for a crop genepool.

In situ conservation of wild relatives of crops has been extensively reviewed by Meilleur and Hodgkin (2004). Country wise summaries on *in situ* crop wild relatives conservation activities are presented and recommendations are made for future action. Principal recommendations include highlighting appropriate taxa as crop wild relative in botanical and conservation databases, undertaking gap analysis to locate crop wild relative's hotspots and enhancing cooperation among conservation scientists. Detailed analysis of the protected area network in India along with state wise list and sanctuary wise area under protective coverage are given by Rodgers *et al.* (2002).