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EXPLORATION AND STUDY OF THE DIVERSE ECOTYPES OF VEGETABLE MELONS (*CUCUMIS MELO*) IN COMPARISON WITH CUCUMBERS (*CUCUMIS SATIVUS*) FOR INTERSPECIFIC HYBRIDIZATION, TAXONOMIC STUDY AND ORGANOLEPTIC ANALYSIS

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ABSTRACT
Cucumis melo L. represents a highly diverse group within the genus Cucumis, consumed as a fruit and a vegetable. The melo species divides into two primary sub-species, *agrestis* and *melo*, exhibiting significant diversity in fruit traits, frequently complicating the identification of sub-species. The *Cucumis melo* cultivars, commonly known as melo in English and "southekayi" in the local language Kannada, share many similar fruit traits with *Cucumis sativus*. Most of the fruit traits are similar in both the species, hence these local *melons* are confused with sativus types. For the development of improved varieties in *melos* their taxonomic identification is prerequisite. To discern the species and its taxonomy, 32 local cultivars *Cucumis melo* were subjected to interspecific hybridization with *Cucumis sativus* testers, utilizing a Line X Tester analysis approach. We conducted a taxonomic investigation by comparing growth, vegetative, and fruit traits of *melos* and *sativus* types. While interspecific crosses yielded no success, intraspecific hybridization produced fertile hybrids among local cultivars. Taxonomic assessment distinguished certain traits that set apart local ecotypes from *sativus* types. Evaluation of fruit quality traits, based on five plants per cultivar, revealed a wide range of characteristics, including color (from light to dark green), secondary patterns (blotches to lines), and shapes (round to oblong), alongside varying fruit textures (soft to hard). Organoleptic testing categorized cultivars for salads, pickling, and curry preparation. This study confirms these local cultivars as part of the *Cucumis melo* sub-species *agrestis*. It highlights the urgency of conserving and utilizing these races to develop improved varieties, given their rich source of favourable alleles and potential for meeting contemporary needs.

KEYWORDS: *Cucumis melo, Cucumis sativus, Agrestis*, Organaleptic, Local ecotypes, Hybridisation, Taxonomic classification

1. INTRODUCTION
The family Cucurbitaceae stands out for its remarkable diversity, ranking as the largest among vegetable crops. Comprising 118 genera and 825 species, numerous subspecies within this family are globally distributed, predominantly inhabiting tropical and subtropical regions [1]. Cucumis encompasses over 30 species, including the economically significant cucumber widely cultivated worldwide [2].Notably, *Cucumis melo* and *Cucumis sativus* represent extensively cultivated members of this genus, with the latter commonly referred to as cucumbers and the former as melons. While melons are consumed as fruits and vegetables, *sativus* types are primarily used as vegetables. Unlike *sativus* types, *melo* types exhibit substantial diversity in growth patterns, yield, and fruit quality traits.
C. melo L. (2n=24) is broadly classified into two subspecies: melo and agrestis, each further categorized into distinct botanical groups. *Agrestis* encompasses groups like conomon, *makua, acidulus, momordica,* and *chinensis,* while *melo comprises cantalupensis, chandalak, ameri, indorus, flexosus, chito, chate, tibish, adana, reticulatus, and dudaim* [3]. These botanical groups showcase significant diversity in fruit morphology, including size, shape, color, and quality attributes like moisture content, beta carotene, and other minerals. *C. sativus* (2n=14) consists of two subspecies: C. *sativus*

var. *sativus* and *C. sativus* var. *hardwickii*, ranking as the third most crucial vegetable crop within the cucurbit family and holding the fourth position in global vegetable production [4]. India is the primary centre of origin for both *sativus* and *melo* types, substantial variability exists in yield and quality parameters within local collections. Although most Indian collections consist of melo types, both species hold significance due to their utility and nutritional attributes. *Sativus* types are classified into various categories, including slicing cucumbers, burpless cucumbers, pickling cucumbers (Gherkins), and those utilized for curry preparation. Generally abundant in moisture content, these fruits are commonly employed for salads and pickling. Conversely, melons are categorized into sweet and nonsweet variants, with muskmelons and snap melons representing the sweet category and culinary melons representing the nonsweet category. While many botanical groups of melons are consumed as vegetables, nonsweet types dominate. The nonsweet or culinary forms of *Cucumis melo* form a distinctive group distributed across the humid tropics of Southern India, demonstrating adaptability to diverse tropical environmental conditions [5].These are classified as oriental pickling melons, sambhar southe, or culinary melons, each group serving a specific purpose.

Commercially cultivated local cultivars primarily comprise melons and open-pollinated varieties, contributing to a high degree of diversity in the base population. In Karnataka, many local ecotypes of *Cucumis melo* are often misidentified as *sativus* types due to the extensive diversity within melons and the similarity of fruit morphological traits with *sativus* types, such as fruit length, color, texture, shape, stripes, moisture content, and taste. These local cultivars, called cucumbers, are mainly of the culinary type, grown across districts in Karnataka, including Bagalkot, Belgaum, Bijapur, and Badami. They are commonly known as "southekayi" or "yare southe" in the regional language (Kannada), which is also the common name for sativus types. These cultivars are preferred for their distinct flavor, taste, and other fruit quality traits. Substantial variability in morphological traits arises from the cross-pollination nature of cucumbers, and this species stands alone in its ability to be used in various dishes. These diverse ecotypes are found in salads, pickles, and curry preparation at different stages of fruit maturity. *Cucumis melo* boasts wide-ranging fruit traits, including size, shape, color, texture, and composition [6], [7]. This extensive diversity in melons has been documented by many researchers in their studies [8], [9], [10], and [11]. Local cultivars lack botanical descriptors, rendering them unclassified within existing botanical groups. These cultivars exhibit varying fruit characteristics, separating them from established botanical groups. Unfortunately, this group of melons has not been extensively utilized in crop improvement programs despite harboring numerous desirable traits [12]. The taxonomy and species name of these ecotypes are essential prerequisites for incorporating them into crop improvement programs. In the present investigation, three distinct studies were conducted: interspecific hybridization to assess compatibility, taxonomic studies utilizing available descriptors for Cucumis species to characterize local ecotypes and *sativus* types (Testers) based on growth, vegetative, and fruit traits, and organoleptic evaluation of fruit quality traits to confirm the identity of the ecotypes and their botanical group.

2. METHODS

The experiment was conducted at the College of Horticulture, University of Horticultural Sciences, Bagalkot, during the *Kharif* season of 2019-20. Germplasm exploration was carried out in the northern regions of Karnataka, encompassing districts such as Bagalkot, Belgaum, Bijapur, and Gokak. A total of 32 local collections, along with three *sativus* types, were selected for evaluating vegetative and fruit quality traits (Table 1). Ten plants from each cultivar were maintained in the field, spaced at 1 x 3 meters. Five plants per cultivar were marked for data collection. The study encompassed three distinct experiments to ascertain the species and confirm the botanical group of these cultivars.

Table 1. Details of the experimental material

Sl.No	Genotypes	Code	Species
1	Bagalkot local	UHSCS-1	*Cucumis melo*
2	Jammanakatti	UHSCS-2	*Cucumis melo*
3	Ghataprabha	UHSCS-3	*Cucumis melo*
4	Yadahalli	UHSCS-4	*Cucumis melo*
5	Bannidinni	UHSCS-17	*Cucumis melo*
6	Mysore	UHSCS-27	*Cucumis melo*
7	Devarahipparagi-S	UHSCS-13	*Cucumis melo*
8	Neeralkeri	UHSCS-21	*Cucumis melo*
9	BLG-local	UHSCS-36	*Cucumis melo*
10	Bijapur	UHSCS-59	*Cucumis melo*
11	Arabhavi	UHSCS-44	*Cucumis melo*
12	B2	UHSCS-51	*Cucumis melo*
13	28-3-S	UHSCS-28	*Cucumis melo*
14	26-6-S	UHSCS-26	*Cucumis melo*
15	13-6-S	UHSCS-13	*Cucumis melo*
16	Bailhongal	UHSCS-79	*Cucumis melo*
17	Gokak-18	UHSCS-78	*Cucumis melo*
18	Dhenu seeds	UHSCS-82	*Cucumis melo*

19	Devarahipparagi	UHSCS-57	*Cucumis melo*
20	Giriyal ghataprabha	UHSCS-18	*Cucumis melo*
21	UHCS-14	UHSCS-16	*Cucumis melo*
22	Jammanakatti long	UHSCS-7	*Cucumis melo*
23	UHCS-31	UHSCS-15	*Cucumis melo*
24	Local OPV	UHSCS-11	*Cucumis melo*
25	Bailhongal -1	UHSCS-79	*Cucumis melo*
26	12th line	UHSCS-39	*Cucumis melo*
27	Local long	UHSCS-9	*Cucumis melo*
28	UHCS-15	UHSCS-14	*Cucumis melo*
29	UHCS-33	UHSCS-20	*Cucumis melo*
30	Local UHSCS-32	UHSCS-12	*Cucumis melo*
31	Mallapur local	UHSCS-56	*Cucumis melo*
32	3rd line	UHSCS-41	*Cucumis melo*
33	Swarna sheetal	UHSCS-T1	*Cucumis sativus*
34	Pusabharka	UHSCS-T2	*Cucumis sativus*
35	Poinsette	UHSCS-T3	*Cucumis sativus*

*UHSCS- UHS Cucumis species

2.1 Interspecific hybridization

The first experiment focused on interspecific hybridization between local cucumber cultivars and *sativus* types as testers. A total of 12 local cucumber cultivars were crossed with three sativus testers, namely Swarna Sheetal (T1), Pusa Barkha (T2), and Poinsett (T3), in a Line x Tester (L x T) manner (Table 2). Monoecious flowers were bagged with butter paper bags two days before flowering to prevent cross-pollination. Pollen from freshly opened flowers of testers was collected in the early morning hours (between 6-6:30 am) using a muslin cloth or a brush for pollination. The collected pollen was applied to the pre-bagged stigmas of female flowers before 7:30 am, when the stigma was receptive. The pollinated flowers were labeled and tagged with butter bags until fruit set, with 30 crosses per cultivar. On average, ten flowers per tester were crossed from each cultivar.

Table 2: Layout of crossing block for the development of F1 hybrids

	UHSCS- T1	**UHSCS – T2**	**UHSCS-T3**
UHSCS-21	×	×	×
UHSCS-27	×	×	×
UHSCS-1	×	×	×
UHSCS-17	×	×	×
UHSCS-2	×	×	×
UHSCS-51	×	×	×
UHSCS-3	×	×	×
UHSCS-79	×	×	×
UHSCS-13	×	×	×
UHSCS-26	×	×	×
UHSCS-21	×	×	×
UHSCS-28	×	×	×
UHSCS-36	×	×	×
UHSCS-59	×	×	×
UHSCS-44	×	×	×

2.2 Taxonomic study

The taxonomic study involved characterizing these cultivars based on available descriptors. For vegetative parameters, five plants from each cultivar were observed according to the descriptors of *Cucumis melo* (IPGRI 2003) (Table 3). Fruit qualitative traits were evaluated by randomly selecting five fruits from each cultivar for visual observations (Table 4). Due to the diversity of fruit quality traits, which often resembled those of other botanical groups, a detailed investigation was explicitly conducted, focusing on fruit traits.

Table 3. Scores for vegetative parameters (IPGRI, descriptors).

Pubescence on stem	
Absent	1
Present	9
Texture of leaf surface	
Leathery	1
Non leathery	9
Pubescence on leaves	
Absent	0
Present	1
Ovary pubescence	
Present	1
Absence	3
Sex expression	
Monoecious	1
Gynoecious	2

Table 4: Score card for evaluation of fruit quality traits as per the descriptors (as per the DUS guidelines of Varanasi)

Fruit Length	**Score**
Short (< 10 cm)	1
Medium length (< 10-15 cm)	2
Long fruit (>15 cm)	3
Fruit: Spines	**Score**
Absent	0
Presennt	1
Fruit:Colour	
Creamy white	1
Yellow	2
Light green	3
Dark green	4
Fruit: Stripes	
Present	1
Absent	9
Fruit: Bitterness	
Bitter	1
Non bitter	0
Fruit : Texture	
Rough	2
Smooth	1
Fruit : Taste	
Insipid	3
Intermediate	5

Sweet	7
Fruit : Aroma at fully ripe stage	
Present	1
Absent	0

2.3 Organoleptic evaluation

The organoleptic evaluation involved assessing fruit quality traits in freshly harvested fruits from five plants of each cultivar. Fifteen participants evaluated the fruit taste, color, acceptability, texture, bitterness, and overall taste. The cultivars were categorized for pickling, salad, and vegetable purposes based on sensory evaluation and acceptability. Many of these cultivars are consumed raw at immature stages as salad crops. In later stages, based on fruit texture, they are used for pickling and even curry preparation. Fully ripened fruits were also assessed for aroma, a characteristic feature of melons that distinguishes them from *sativus* types.

3. RESULTS

3.1 Interspecific Hybridization For Species Identity Revealed Local Cultivars As Melons

A comprehensive study was undertaken to ascertain the species identity through interspecific hybridization between carefully selected local cultivars and *sativus* types. A representative set of twelve high-yielding cultivars with desirable fruit quality attributes was chosen from several with similar morphological traits. These cultivars were used as female parents in conjunction with *sativus* types as tester parents in a Line x Tester (L x T) experimental design. Reciprocal crosses were also attempted, encompassing multiple combinations between the lines and testers. Despite our concerted efforts, it is noteworthy that none of the crosses resulted in a successful fruit set. Instead, the flowers failed to develop into fruits, eventually withering and detaching before any fruit set occurred. This trend was consistent across all interspecific crosses, even after conducting more than 50 crosses per parental combination.

The outcomes of these interspecific crosses indicate that local cultivars do not exhibit compatibility with *sativus* types. The absence of a fruit set, coupled with the withering and dropping of flowers in all interspecific crosses, strongly suggests that the local cultivars do not belong to the *sativus* species. This revelation proves that the local *melo* and *sativus* types are distinct species, marked by their incompatibility in interspecific hybridization attempts.

3.2 Taxonomic Evaluation via Vegetative and Fruit Quality Parameters to Differentiate Local Ecotypes of Melons and Sativus Types

The evaluation of ecotypes based on taxonomy involved the assessment of vegetative and fruit quality parameters in distinguishing between *melo* and *sativus* types. For this purpose, five fruits were randomly selected from each genotype, and various growth parameters were considered, including growth habit, leaf shape, stem pubescence, ovary pubescence, sex expression, and leaf texture. These parameters were utilized to differentiate and identify these local cultivars. The findings unveiled that the plants exhibited a vine-like growth pattern ranging from 90 cm to 2 meters in length, with foliage ranging from green to dark green, setting them apart from *sativus* types. The leaves of the local cultivars were smaller in area, typically round or pentagonate, with 3 to 6 shallow lobes, in contrast to the broader, pointed leaves of *sativus* types (Fig. 1A and 1B).

Fig 1A. Leaf shape of *Cucumis sativus*

Fig 1B. Leaf shape of *Cucumis melo*

Furthermore, the stems displayed less pubescence, while the leaves lacked pubescence and possessed a smooth texture. In contrast, *sativus* leaves were characterized by a leathery texture. Notably, the ovaries of the local ecotypes lacked hairs or pubescence. Flowers exhibited a range of colors, including light yellow and dark yellow, with few or no hairs on the ovaries. The size and shape of the female flower were correlated with the corresponding fruit size and shape (Fig. 2A and 2B).

Fig 2A. Female and male flowers of *Cucumis melo* **Fig 2B. Female and male flowers of *Cucumis sativus***

Cucumber local ecotypes were characterized based on vegetative parameters, following the descriptors provided by IPGRI (Table 5). Among the five non-parametric traits assessed, ovary pubescence, spines on leaves, and leaf texture emerged as key discriminators between *melo* and *sativus* types. Pubescence was exclusively observed on the stems, leaves, and ovaries for *sativus* kinds, enabling the clear differentiation of *melo* and *sativus* types based on these traits. Notably, the local ecotypes lack pubescence or hairs on their ovaries compared to other *melo* groups, providing a distinct feature that sets them apart from *sativus* types and even distinguishes them from other botanical groups. Despite the similarities between the two species regarding their monoecious sex form, these taxonomically differentiating traits highlight the unique attributes of local ecotypes.

Table 5. Characterization of landraces of cucumber based on vegetative parameters according to the IPGRI descriptors.

SN	Genotypes	Spines /Pubescence on stem	Leaves texture	Pubescence on leaves	Sex expression	Ovary Pubescence/ spines
1	UHSCS-1	Absent	Non leathery	Absent	Monoecious	Absent
2	UHSCS-2	Absent	Non leathery	Absent	Monoecious	Absent
3	UHSCS-3	Absent	Non leathery	Absent	Monoecious	Absent
4	UHSCS-4	Absent	Non leathery	Absent	Monoecious	Absent
5	UHSCS-17	Absent	Non leathery	Absent	Monoecious	Absent
6	UHSCS-27	Absent	Non leathery	Absent	Monoecious	Absent
7	UHSCS-13	Absent	Non leathery	Absent	Monoecious	Absent
8	UHSCS-21	Absent	Non leathery	Absent	Monoecious	Absent
9	UHSCS-36	Absent	Non leathery	Absent	Monoecious	Absent
10	UHSCS-59	Absent	Leathery	Absent	Monoecious	Absent
11	UHSCS-44	Absent	Non leathery	Absent	Monoecious	Absent
12	UHSCS-51	Absent	Non leathery	Present	Monoecious	Absent
13	UHSCS-28	Absent	Non leathery	Absent	Monoecious	Absent
14	UHSCS-26	Absent	Non leathery	Absent	Monoecious	Absent
15	UHSCS-13	Absent	Non leathery	Absent	Monoecious	Absent
16	UHSCS-79	Absent	Non leathery	Absent	Monoecious	Absent
17	UHSCS-78	Absent	Non leathery	Absent	Monoecious	Absent
18	UHSCS-82	Absent	Non leathery	Present	Monoecious	Present
19	UHSCS-57	Absent	Non leathery	Absent	Monoecious	Absent
20	UHSCS-18	Absent	Non leathery	Absent	Monoecious	Absent
21	UHSCS-16	Absent	Non leathery	Absent	Monoecious	Absent

22	UHSCS-7	Absent	Non leathery	Absent	Monoecious	Absent
23	UHSCS-15	Absent	Non leathery	Absent	Monoecious	Absent
24	UHSCS-11	Absent	Non leathery	Absent	Monoecious	Absent
25	UHSCS-79	Absent	Non leathery	Absent	Monoecious	Absent
26	UHSCS-39	Absent	Non leathery	Absent	Monoecious	Absent
27	UHSCS-9	Absent	Non leathery	Absent	Monoecious	Absent
28	UHSCS-14	Absent	Non leathery	Absent	Monoecious	Absent
29	UHSCS-20	Absent	Non leathery	Absent	Monoecious	Absent
30	UHSCS-12	Absent	Non leathery	Absent	Monoecious	Absent
31	UHSCS-56	Absent	Non leathery	Absent	Monoecious	Absent
32	UHSCS-41	Absent	Non leathery	Absent	Monoecious	Absent
33	UHSCS- T1	Present	Leathery	Present	Monoecious	Present
34	UHSCS -T2	Present	Leathery	Present	Monoecious	Present
35	UHSCS -T3	Present	Leathery	Present	Monoecious	Present

3.3 Fruit Quality Assessment Reveals Variability in Traits Among Local Ecotypes Melons and Sativus Types

The characterization process also encompassed an assessment of fruit quality traits. Thirty-five genotypes were categorized based on distinct fruit quality parameters (Table 6). Fruit length exhibited a wide range, extending from short to long. Local cucumbers stood out for their attractive appearance, with fruit lengths varying from 5 cm to over 30 cm, distinguishing them from other *melo* types. Notably, spines on the fruit surface were exclusively present on *sativus* types in their immature stages, while only some local cucumber cultivars exhibited such spines, while melons were not associated with prominent spines at the harvest stage (Fig. 3A and 3B).

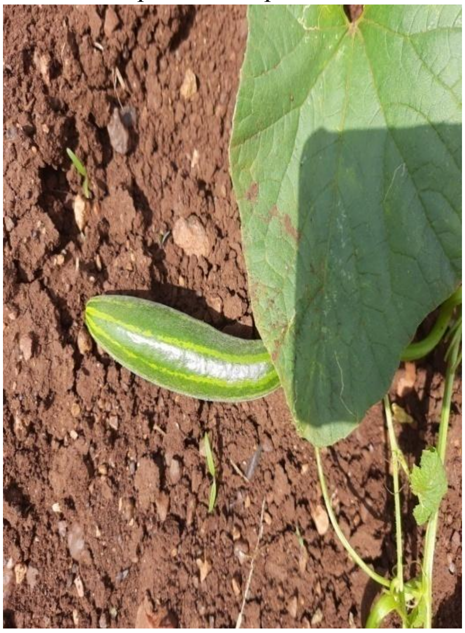

Fig 3A. Fruits of *C. melo* at harvest stage

Fig 3B. Fruits of *C. sativus* at harvest stage

Table 6. Characterization of landraces of cucumber based of fruit quality traits

Genotypes	Fruit shape	Fruit length	Fruit spines	Fruit colour	Stripes on fruit surface	Flesh colour	Bitterness	Fruit Texture	Fruit Taste	Aroma at fully ripe stage	Moisture content
UHS CS-1	Elongate	Long	Absent	Dark green	Less	Creamish yellow	Non bitter	Smooth	Intermediate	Present	Intermediate
UHS CS-2	Elongate	Long	Absent	Dark green	Less	Creamish yellow	Non bitter	Rough	Intermediate	Present	Less

UHS CS-3	Elongate	Long	Absent	Dark green	Less	Creamish yellow	Non bitter	Smooth	Intermediate	Present	High
UHS CS-4	Elongate	Long	Absent	Light green	Prominent	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-17	Elongate	Long	Absent	Dark green	Less	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-27	Elongate	Long	Absent	Dark green	Prominent	Cream	Non bitter	Smooth	Intermediate	Present	Less
UHS CS-13	Elongate	Long	Absent	Yellowish green	Less	Cream	Non bitter	Smooth	Intermediate	Present	High
UHS CS-21	Elongate	Long	Absent	Dark green	Prominent	Cream	Non bitter	Smooth	Intermediate	Present	High
UHS CS-36	Elongate	Long	Absent	Light green	Less	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-59	Elongate	Long	Absent	Dark green	Less	Cream	Non bitter	Smooth	Inspid	Present	Less
UHS CS-44	Elongate	Long	Absent	Dark green	Less	Cream	Non bitter	Smooth	Intermediate	Present	Less
UHS CS-51	Elongate	Long	Absent	Light green	Prominent	Creamish yellow	Non bitter	Rough	Intermediate	Present	Less
UHS CS-28	Elongate	Short	Absent	Light green	Prominent	Creamish yellow	Non bitter	Rough	Inspid	Present	Less
UHS CS-26	Elongate	Long	Absent	Dark green	Prominent	light green	Non bitter	Rough	Inspid	Present	Less
UHS CS-13	Elongate	Long	Absent	Dark green	Prominent	Creamish yellow	Non bitter	Smooth	Intermediate	Present	More
UHS CS-79	Elongate	Long	Absent	Light green	Less	light green	Non bitter	Smooth	Inspid	Present	More
UHS CS-78	Oblong	Long	Absent	Light green	Prominent	Creamish yellow	Non bitter	Smooth	Inspid	Present	More
UHS CS-82	Oblong	Long	Absent	Light green	Prominent	light green	Non bitter	Rough	Inspid	Present	Less
UHS CS-57	Elongate	Long	Absent	Dark green	Less	Creamish yellow	Non bitter	Smooth	Intermediate	Present	Intermediate
UHS CS-18	Elongate	Long	Absent	Light green	Prominent	Cream	Non bitter	Smooth	Intermediate	Present	Intermediate
UHS CS-16	Oblong	Long	Absent	Light green	Prominent	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-7	Oblong	Long	Absent	Dark green	Prominent	Cream	Non bitter	Rough	Inspid	Present	Less
UHS CS-15	Elongate	Long	Absent	Creamy white	Prominent	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-11	Elongate	Short	Absent	Light green	Prominent	Creamish yellow	Non bitter	Smooth	Intermediate	Present	Less

UHS CS-79	Elongate	Long	Absent	Light green	Less	Cream	Non bitter	Smooth	Inspid	Present	Less
UHS CS-39	Elongate	Long	Absent	Light green	Less	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-9	Elongate	Long	Absent	Light green	Prominent	Cream	Non bitter	Smooth	Inspid	Present	Intermediate
UHS CS-14	Elongate	Long	Absent	Light green	Less	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-20	Elongate	Short	Absent	Dark green	Less	Cream	Non bitter	Smooth	Intermediate	Present	Less
UHS CS-12	Elongate	Long	Absent	Dark green	Prominent	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-56	Elongate	Long	Absent	Light green	Prominent	Cream	Non bitter	Rough	Intermediate	Present	Less
UHS CS-41	Elongate	Long	Absent	Dark green	Prominent	Cream	Bitter	Rough	Intermediate	Present	Less
UHS CS-T1	Cylindrical	Long	Present	Dark green	Prominent	light green	Non bitter	Rough	Sweet	Absent	High
UHS CS - T2	Cylindrical	Long	Present	Yellowish green	Prominent	light green	Non bitter	Rough	Sweet	Absent	High
UHS CS - T3	Cylindrical	Long	Present	Light green	Prominent	light green	Non bitter	Rough	Intermediate	Absent	High

A diverse array of fruit colors was observed, spanning from light green to dark green, with some cultivars even displaying a creamish green hue. Stripes on the fruit surface varied in prominence, and fruit shape encompassed variations from oblong to elongate or straight in the local ecotypes, while *sativus* types adopted a cylindrical form. Moisture content exhibited significant variability, ranging from low to high, with *sativus* types generally featuring higher moisture content. Flesh colour also displayed diversity, ranging from creamish to light green tones. Both *melo* and *sativus* types were considered non-bitter, with tastes varying from insipid to sweet. The texture of ecotypes' fruit varied from soft to hard, unlike all *sativus* types, which uniformly exhibited a hard texture. Based on the fruit quality traits the local ecotypes are classified into pickling, salad, vegetable and processing purpose (Table 7)

Table 7. Classification of Melons based on organoleptic evaluation and according to their usage

SN	Usage	Fruit length	Friut texture	Fruit surface	Flesh colour	Flesh texture	Taste of fruit	Moisture content	Peeling of skin
1	Pickling	<10cm	Soft	Smooth	Light green and	Crunchy	Sweet	more	Not required
2	Salad	8-25 cm	Soft	Smooth	Light green to dark green	Crunchy	Sweet	More	Not required
3	Vegetable –curry preparation	>10 cm	Intermediate	Intermediate	Darkgreen-Yellowish green	Granular	Mild sweet and salty	Less	Not required
4	Juice and health drinks	>10 cm	Intermediate	Intermediate	Yellowish – orange colour	Smooth	Sour and salty	more	Not required

Individually, the fruit weight demonstrated variations across different harvesting stages, ranging from an average of 60.0 g to more than 1.0 kg. Notably, fruit length and weight fluctuated considerably at immature and mature stages. Furthermore, the evaluation for fruit aroma at the fully ripe stage confirmed that all local cultivars emitted a distinct aroma reminiscent of melons. In contrast, testers were devoid of any discernible aroma.

4. DISCUSSION

4.1 Cross-Incompatibility with Sativus Affirms Taxonomic Placement of Local Ecotypes within the Melon Group

The classification within the *Cucumis melo* species at the intraspecific level poses considerable challenges due to the abundant diversity present and the significant overlap in many fruit traits. This difficulty is exacerbated by the need for more available descriptors for taxonomic identification [8,13]. In our current study, an endeavour was made to shed light on this matter by conducting crosses between 12 local ecotypes and three sativus types as testers to explore compatibility. However, no fruit set was achieved due to the evident incompatibility between the parental lines.

This outcome aligns with previous reports indicating that disparities in chromosome numbers underlie such incompatibilities. Notably, the distinct chromosome numbers between *sativus* (X=7) and *melo* (X=12) types lead to the observed incompatibilities [14]. In our study, the testers possessed a chromosome count of 2n=14, while the *melo* types exhibited 2n=24. A further crossing program was undertaken to generate intraspecific hybrids among the local *melo* types, successfully developing fertile hybrids. It is essential to highlight that *Cucumis melo* is the most diverse species within the Cucumis genus, featuring various botanical groups that display cross-compatibility. Building upon prior research, it is noteworthy that interspecific crosses tend to be sterile, whereas intraspecific crosses within botanical groups yield fertile hybrids [15]. An additional step was taken to validate the results obtained from interspecific hybridization. Intermating was carried out among the 32 local cultivars, all of which belong to the melo types, ultimately leading to the successful creation of fertile hybrids. This result further strengthens the case for classifying these local types within the *melo* group.

4.2 Decoding Taxonomic Relationship through Morphological Diversity

The comprehensive evaluation encompassed vegetative and fruit quality parameters to characterize the local ecotypes and *sativus* types effectively. The findings revealed that local ecotypes exhibit a vine growth habit exceeding 2 meters long. Discernible variations were observed in leaf traits such as colour and shape, differentiating *melo* and *sativus* types. Leaf texture ranged from a smooth to leathery surface, with the notable absence of pubescence on the stem, leaves, and ovaries of local ecotypes, whereas *sativus* types displayed evident pubescence.

Various hypotheses underpin the taxonomic relationship between *sativus* and *melo* types. One prevalent view suggests that X=7 *sativus* types evolved from X=12 *melo* types through unequal translocation or fusion of non-homologous chromosomes. The divergence between *sativus* and *melo* types can be attributed to alterations in chromosome number, nuclear DNA content, reproductive barriers, mutations, and even random drift [16].

Drawing upon earlier literatures, [17] and [7] melon classification involves two subspecies: *agrestis*, characterized by sericeous or appressed ovaries with short or absent pubescence/hairs, and *melo*, featuring pilose or medium to long prominent hairs/pubescence. Notably, most fruit traits of these ecotypes align with those of the newly identified landrace 'Arya' from Rajasthan, grouped under the subspecies melo [18]. However, the absence of ovary hairs/pubescence clearly distinguishes the local ecotypes of *melo* from the Arya group. These collections, devoid of pubescence on immature ovaries, indicate belonging to the *C. melo* subspecies *agrestis.* Importantly, they are not classified within existing botanical groups, representing a novel category that warrants inclusion in botanical descriptors. The presence or absence of ovary pubescence emerges as a pivotal trait that effectively differentiates these local ecotypes from the broader context of *Cucumis melo* subspecies *melo.*

4.3 Fruit Diversity and Culinary Versatility of Local Ecotypes of Melon

Local ecotypes have diverse fruit quality traits, like color, shape, size, and appearance. Fruits are low in moisture content compared to *sativus* types and are crisp and crunchy in taste, which is preferred for salad purposes. Based on the organoleptic evaluation, fruits were classified for salad purposes, pickling and also as a vegetable for curry preparation. The fruits can be directly eaten in an immature stage without peeling the skin, as the fruits are soft, thin, and easily palatable. Based on sensory evaluation, fruits of this cultivar can be used for various purposes based on the maturity stage of the crop. Immature fruits can be used as a salad or for pickling purposes, as fruits are very soft and have rudimentary seeds. At the harvesting stage as a vegetable for culinary purposes, some of the cultivars at the over-ripened stage can be used to prepare sambar or chutney, juice, jam, and other health drinks. Peeling is unnecessary compared to different melo types, as fruit skin is soft and easily palatable. At the fully ripe stage, fruits have an aroma the same as melons, confirming the identity of the local cultivars as melons.

Compared to other meal types, fruits are very attractive; fruit length varies from 5 cm to >30 cm, fruit color varies from creamish yellow to dark green, and stripes on the fruit surface vary from stripes to blotches distributed all along the fruit surface. Fruit shape ranges from oblong to elongate or straight. Moisture content varies from low to high, and flesh color varies from creamish to light green. On average, it varies from 60 gm to >1 kg. Generally, fruit length and weight vary considerably at the immature and mature stages. In comparison with *sativus* types, local ecotypes have broader utility in terms of salad, pickling, and curry, and fully ripened can be used in the preparation of various beverages, viz, Jam, Juice and other forms of energy drink, as fruits have a peculiar aroma and are sour.

5. CONCLUSIONS

The research explored the taxonomy and attributes of local ecotypes within the *Cucumis melo* species. Interspecific hybridization experiments highlighted the incompatibility between local melo cultivars and sativus types, confirming their distinctness. Taxonomic studies based on morphological traits established clear differentiators between the two species. The taxonomic relationship between *sativus* and *melo* types was further explained through chromosomal disparities. Local ecotypes' diverse fruit quality traits, including size, color, texture, and taste, showcased their culinary versatility for salads, pickling, and cooking. The study underscores the unique attributes of these ecotypes, emphasizing their importance in botanical classification and culinary practices.

6. Future Scope

The present investigation will focus on exploration of diverse *Cucumis melo* collections for the development of superior hybrids and varieties for salad, cooking and also for processing purpose with desirable yield and fruit quality traits.

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