Ethno-botanical Knowledge on Diversity of *Cucurbita* Landraces Grown in Northern KwaZulu-Natal, South Africa

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Abstract Ethnobotanical knowledge on local *Cucurbita* landraces was documented in three district municipalities of northern KwaZulu-Natal, South Africa. Seven distinct landraces of *C. argyrosperma*, *C. maxima* and *C. pepo* were identified by local (isiZulu) names as *iNhlwathi emhlophe*, *iNhlwathi emnyama*, *iPhuzi*, *isiPhama*, *iThanga*, *uMpampini oluhlaza* and *uMpampini ophuzi*. The majority had leaves with silvery-white mottling in axils of leaf veins, but *isiPhama* and *uMpampini oluhlaza* had uniformly green leaves. *iNhlwathi emhlophe* and *iNhlwathi emnyama* had the largest fruits and *isiPhama* had the smallest. Landrace *iNhlwathi emnyama* maintained its green fruit colour at maturity, while *iPhuzi* changed to uniform yellow/orange fruit colour before maturity. The *isiPhama*, *uMpampini oluhlaza* and *uMpampini ophuzi* had sparse to moderate stem branching habit and the sweetest, less watery fruits of them all. Seed colour ranged from cream to white. This study was the first attempt to record the genetic-related diversity on types of *Cucurbita* landraces that are grown in South Africa. It also recorded the presence of *C. argyrosperma* for the first time in this country.

Keywords *Cucurbita* Landraces, Indigenous Knowledge, Traditional Leafy Vegetables

1. Introduction

Pumpkins, represented by various *Cucurbita* species, are nutritionally and economically important [1]. Their mature and young fruits, seeds, staminate flowers, leaves and young shoot tips are consumed as leafy vegetables [2, 3]. *Cucurbita* species are important sources of vitamin C, minerals and β -carotene [4]. The genus *Cucurbita* is of American origin and is distributed from United States to Argentina [4, 5]. Of the five domesticated *Cucurbita* species: *C. pepo*; *C. maxima*;

C. moschata; *C. argyrosperma* (*mixta*) and *C. ficilifolia* [1], the former three species are the most cultivated species [5]. In South Africa *Cucurbita pepo* landraces are widely grown and used as a traditional leafy vegetable [6].

A landrace is an early cultivated form of a crop species, evolved from a wild population, and generally composed of a heterogeneous mixture of genotypes [7]. It is also known as traditional and local crop variety particularly used by local farmers [8]. Landraces are the important genetic resources for plant breeders because of their considerable genotypic variation [9].

Cucurbita species vary widely morphologically, genetically and agro-ecologically, where the latter includes tropical and subtropical regions, arid deserts and temperate locations [10]. Their growth habit varies between vine type with vine lengths reaching about 15 m and bush type with shorter vines [5, 11]. Leaves of *Cucurbita* landraces have wide diversity in their size, shape, colour, hairiness and texture [12]. Flowers of *Cucurbita* landraces vary widely in their colour, size and shape [10]. Extreme diversity is found in shape, size and colour of fruits and seeds among *Cucurbita* species [3, 9].

Limited study on collection and conservation of *C. maxima* and *C. pepo* accessions was initiated in KwaZulu-Natal midlands and Limpopo provinces of South Africa [13]. No work to date has recorded the *Cucurbita* landraces that are grown by smallholder farmers and collected the available knowledge on these vegetables, in northern KwaZulu-Natal province, South Africa. Identification and characterization of diversity in landraces provide breeders with considerable amount of information concerning their value to particular breeding programs. Breeders may then exploit these genetic resources in several ways to produce new cultivars. The objectives of this study were to identify different *Cucurbita* landraces that are grown and to document ethno-botanic knowledge on their characterization in three district municipalities of northern KwaZulu-Natal.

2. Materials and Methods

The survey was conducted in Umkhanyakude (Mseleni: 27° 38' S, 32° 47' E), uThungulu (Nkandla: 28° 37' S, 31° 25' E) and Zululand (Ulundi: 28° 32' S, 31° 47' E) district municipalities of northern KwaZulu-Natal. The interviews through structured questionnaires were conducted in isiZulu in a total of 450 households. In each district, three villages were chosen where fifty households per village were interviewed. To consolidate the information obtained from household interviews, focus groups of three to ten people per group were interviewed using garden and general community meetings.

Interviewees listed different types of *Cucurbita* landraces and characterized them according to their stem (hairiness and branching habit), leaf (mottling and hairiness), fruit (speckling, size, shape and internal hollowness) and seed (shape and colour); and also recorded the part(s) used for vegetable purposes. Additional information such as derivation of landrace name, fruit sweetness and water content was recorded as per interviewees' note. Ten plants per each landraces were studied to confirm the interviewees' reports especially on plant morphological features.

Voucher specimens were collected concurrently with interviews. However, in cases where only seeds were available with the communities, they were grown at the University of Zululand Ethno-Botanic Garden for the preparation of voucher specimens as according to Fish [14].

3. Results

Seven distinct *Cucurbita* landraces were identified in the surveyed areas (Table 1). The incidence of occurrence and/or knowledge as determined by the number of specimens studied per landraces per district is also indicated in this table. These landraces belonged to the following *Cucurbita* species: *C. argyrosperma* (*isiPhama*); *C. maxima* (*uMpampini oluhlaza*); *C. maxima/pepo* (*uMpampini ophuzi*); and *C. pepo* (*iNhlwathi emhlophe*, *iNhlwathi emnyama*, *iPhuzi* and *iThanga*). Their names were derived mainly from mature fruit colour and variegation. However, the meanings of *isiPhama* and *iThanga* landraces were uncertain. When excluding *uMpampini ophuzi* landrace, the *C. pepo* had the

highest number (four) of landraces. The *iThanga* and *uMpampini oluhlaza* landraces were known in all districts. The *isiPhama*, *iNhlwathi emnyama* and *iNhlwathi emhlophe* landraces were known only at Umkhanyakude district; *iPhuzi* at Zululand district; and *uMpampini ophuzi* only at uThungulu district. *uMpampini oluhlaza* landrace is also known as *uZulu* and *uGubungu* at uThungulu and Zululand districts. The majority of *Cucurbita* landraces had profuse stem branching habit except *isiPhama*, *uMpampini ophuzi* and *uMpampini oluhlaza* landraces. Leaves of only *isiPhama* and *uMpampini oluhlaza* landraces were uniformly green with soft hairs but other landraces had green and silvery-white mottling leaves with tough prickly hairs (Table 1; Figure 1).

Fruit shape and size varied widely in all landraces, except the fixed small sizes of *isiPhama* and *uMpampini ophuzi* landraces. *Cucurbita pepo* landraces had significant differences in their mature fruit colour (Table 1; Figure 1). *iNhlwathi emnyama* landrace maintained its deep green or deep green speckled light green at maturity, while *iPhuzi* landrace changed to pure yellow/orange before the hardening of fruit rind. Only *isiPhama* landrace had white-coloured seeds, and only *uMpampini oluhlaza* landrace had ovoid, bulged seed shape. Fruits of most *Cucurbita* landraces were hollow inside. However, fruits of *isiPhama* and *uMpampini oluhlaza* landraces were completely filled internally, whereas fruits of *uMpampini ophuzi* were intermediate.

uMpampini ophuzi landrace had distinct features of both *C. maxima* (fruit shape) and *C. pepo* (stem spines; leaf mottling and hairiness; fruit speckling; seed shape and colour). However, its stem branching habit and fruit internal hollowness was intermediate.

Communities of northern KwaZulu-Natal consume leafy shoot tips, flowers, young and mature fruits, and seeds of *Cucurbita* landraces. The shoot tips of many landraces were picked for vegetable consumption until senescence, except *uMpampini oluhlaza* landraces which developed a bitter taste with age. Therefore their consumption was enjoyed at their early stages of growth and particularly during famine. Nevertheless, cooked fruits of *isiPhama*, *uMpampini oluhlaza* and *uMpampini ophuzi* landraces were the sweetest and less watery, thus were most preferred. However, they had a limitation of very low fruit yield.

Table 1. *Cucurbita* landraces with qualitative stem, leaf, fruit and seed characters generated from the survey (n=450)

Landrace name	Scientific name	Voucher	District(s) (specimen studied)	Stems	Leaves	Fruits, seeds and taste (sweetness and texture)
<i>iNhlwathi emhlophe</i>	<i>C. pepo</i>	NRN 510	M (13)	Tough prickly spines; profuse branching habit	Green mottled silvery-white on veins; tough prickly hairs	Very large round, ovoid and oblong, yellow/orange speckled white at maturity, hollow inside. Flattened cream seeds. Sweet and watery cooked fruits.
<i>iNhlwathi emnyama</i>	<i>C. pepo</i>	NRN 511	M (10)	Tough prickly spines; profuse branching habit	Green mottled silvery-white on veins; tough prickly hairs	Very large round, ovoid and oblong, either deep green or dark green speckled light green up to maturity, hollow inside. Flattened cream seeds. Sweet and less watery cooked fruits.
<i>iPhuzi</i>	<i>C. pepo</i>	NRN 513	Z(150)	Tough prickly spines; profuse branching habit	Green mottled silvery-white on veins; tough prickly hairs	Large to very large, round, ovoid and oblong, light green speckled white at a very tender stage but change to full yellow/orange before reaching maturity, hollow inside. Flattened cream seeds. Tasteless to mild sweet and watery cooked fruits.
<i>isiPhama</i>	<i>C. argyrosperma</i>	NRN 507	M (4)	Soft whitish spines (hairs); sparse branching tendency	Green, with soft hairs.	Small, round to ovoid, grayish-green, filled inside. Thin edible rind. Flattened white seeds. Very sweet and less watery cooked fruits.
<i>iThanga</i>	<i>C. pepo</i>	NRN 353	M (150), T(150), Z(150)	Tough prickly spines; profuse branching habit	Green mottled silvery-white on veins; tough prickly hairs	Small to large round, ovoid and oblong, yellow/orange speckled white at maturity, hollow inside. Flattened cream seeds. Tasteless to mild sweet and watery cooked fruits.
<i>uMpampini oluhlaza</i>	<i>C. maxima</i>	NRN 508	M (7), T (18), Z (26)	Soft hairs when plant is young but become tough and prickly with age; sparse to moderate branching habit	Green, with soft to moderately tough hairs.	Large, flattened to round, ribbed, grayish-green, filled inside. Ovoid, bulged cream seeds, with a peeling outer cover. Very sweet and less watery cooked fruits.
<i>uMpampini ophuzi</i>	<i>C. maxima/pepo</i>	NRN 512	T (6)	Tough prickly spines; sparse to moderate branching habit	Green mottled silvery-white on veins; tough prickly hairs	Small, flattened to round, ribbed, yellow/orange speckled white, partly filled inside. Flattened cream seeds. Very sweet and less watery cooked fruits.

Landrace names are in isiZulu. Voucher: NRN, NR Ntuli. Districts: M, Umkhanyakude; T, uThungulu; Z, Zululand.

A

B

C

F

D

G

H

E

I

Figure 1. Fruits and shoots of *C. argyrosperma* (A, B & C); *C. maxima* (D, E & F) and *C. pepo* (G, H & I) landraces.

4. Discussion

Seven landraces of *C. argyrosperma*, *C. maxima* and *C. pepo* species whose names were derived from mature fruit colour and variegation, were identified in northern KwaZulu-Natal. In Manicaland province, Zimbabwe, seven identified *C. maxima-moschata* landraces' names were coined from the leaf and fruit colour ("Nzunzu"), fruit size ("Ditimanga"), taste of the fruit ("Ndodo") and from rind thickness ("Hokore") [12].

Countries such as Bangladesh [15], Egypt [1], Nigeria [10], and Turkey [9, 16], have different numbers of *Cucurbita* species accessions. However, in South Africa the Agricultural Research Council genebank in Roodeplaat, has a total of 36 *C. pepo* and *C. maxima* accessions that were only collected from Bushbuckridge, Polokwane and Ladysmith areas [13]. Therefore documentation of indigenous knowledge, confirmation of the supplied indigenous information through agronomic and molecular characterization, and conservation of these landraces is essential for *Cucurbita* breeding, improvement and increase in accessions (genetic diversity) in South Africa.

Former research on cultivated *Cucurbita* species in South Africa focused only on *C. maxima*, *C. moschata* and *C. pepo* [2, 13, 17, 18], but have not included *C. argyrosperma*. This might be caused by limited cultivation of *C. argyrosperma* in this country, as it was known by few individuals of Mbazwana and Mseleni villages at Umkhanyakude district only. It could also result from this landrace becoming extinct from all parts of South Africa and is rarely grown by communities; as in accordance with the study of *C. pepo* landraces in Jordan [19]. Therefore its conservation and improvement is essential.

Stem branching habit ranged from sparse through moderate to profuse, which is associated with bush, intermediate and vining growth habits, respectively. This stem branching and growth habit is probably genetically controlled. *Cucurbita* plants with bushy growth habit have monogenic inheritance in which the bush genotype is dominant (*Bu*) to vine genotype (*bu*) and is expressed in early stages of development [11]. Bush-type *Cucurbita* plants have fewer lateral shoots than vine plants [5], which was the case in the diversity of stem branching reported among *Cucurbita* landraces of northern KwaZulu-Natal.

Leaf colour varied from uniformly green to green with silvery-white mottling in the axils of the leaf veins. This variation could be attributed to genetic differences among *Cucurbita* landraces. A range from light to dark green leaf colour exists among *C. moschata* accessions [20]. The silvery-white mottling in the axils of leaf veins among accessions of *C. maxima*, *C. moschata* and *C. pepo* is controlled by a single dominant gene, *M* [21].

Variation from soft to tough prickly spines or hairs on both stems and leaves of *Cucurbita* landraces of northern KwaZulu-Natal concurs with the findings of Ndoro et al. [12] in *Cucurbita* landraces of Zimbabwe. The absence of trichomes in some *C. maxima* leaves is caused by a recessive

allele, *gl* [21]. Also, the foliage of *C. pepo* is ordinarily harshly spiculate, due to stiff, spiny trichomes. However, spinelessness which sometimes occurs in this species is conferred by single recessive genes, *spn* [21].

High diversity in fruit shape, size and colour among *Cucurbita* landraces of northern KwaZulu-Natal concurs with the diversity among *Cucurbita* landraces from Nigeria [10] and *C. maxima* populations of Turkey [9]. This significant variation is probably an indication of high polygenic fruit characteristics that almost defy simple Mendelian analysis in *Cucurbita* species [21]. Two genes affect fruit shape: in *C. pepo*, *Di* controls disc versus pyriform or spherical shape, whereas in *C. moschata*, *Bn* controls butternut (bell) shape, as opposed to the elongated crookneck shape of the homozygous recessive [21]. The dark green colour of mature fruits in *iNhlwathi emnyama* landrace as well as the change of fruit colour from light green to pure yellow or orange before maturity in *iPhuzi* landrace are probably genetically controlled [21, 22].

The internal part of fruits of *Cucurbita* landraces in northern KwaZulu-Natal ranged from hollow through intermediate to completely filled. The completely filled fruits of *C. argyrosperma* (*isiPhama* landrace) and *C. maxima* (*uMpampini oluhlaza* landrace) landraces concurs with the completely filled *C. maxima* fruits studied in Argentina [22].

In the present study seed shape varied from flat to ovoid and bulged seeds among *C. argyrosperma*, *C. maxima* and *C. pepo* landraces. However, Aruah et al. [10] reported only flat seeds among *C. maxima*, *C. moschata* and *C. pepo* landraces. Balkaya et al. [16] reported a range from wide elliptic through elliptic to narrow elliptic seeds among *C. maxima* populations.

Seed colour ranged from cream or light brown (*C. maxima* and *C. pepo* landraces) to white (*C. argyrosperma* landrace). In Nigeria, seed colour ranged from brown through light brown (*C. maxima* and *C. moschata*) to white (*C. pepo*) [10]. Also, in Turkey it varied from white through brown to tawny, among seeds of *C. maxima* populations [16].

The close relationship between *C. argyrosperma* (*isiPhama*) and *C. maxima* (*uMpampini oluhlaza*) landraces in their stem branching habit, leaf colour, and fruit internal hollowness was probably because they both belong to a *Cucurbita pepo* group. This group has four species (*C. pepo*, *C. moschata*, *C. maxima* and *C. argyrosperma*) which are related and cross compatible [10], which could have been the case with the *isiPhama* and *uMpampini oluhlaza* landraces of northern KwaZulu-Natal.

The *uMpampini ophuzi* landrace had distinct qualitative features of both *C. maxima* and *C. pepo* species. This was probably influenced by intercropping these *Cucurbita* landraces, which resulted in gene flow at pollination. The resulting hybrid progeny with mixed genome that was expressed phenotypically and was then maintained for many years by local farmers until established. According to Montes-Hernandez and Eguiarte [23] morphological variation among fruits and seeds of *C. argyrosperma*, *C.*

moschata, and *C. pepo* suggests introgression. The allozyme analysis confirmed introgression among these species and revealed the existence of hybrid progeny from a cross between *C. argyrosperma* and *C. pepo*; and *C. argyrosperma* and *C. moschata*. Among the *Cucurbita* species, *C. argyrosperma* is clearly the most related to *C. moschata* which is the evidence of the gene flow between these inter-planted and naturally open-pollinated species [24]. Aruah et al. [10] reported that *Cucurbita* species are reproductively isolated from each other by genetic barriers and are therefore identified using morphological characters; thus might be the case with *uMpampini ophuzi* landrace.

The consumption of shoot apices, fruits, flowers and seeds of *Cucurbita* landraces agrees with the earlier reports by Jansen van Rensburg et al. [2] and Vorster et al. [25]. However, communities of Mpumalanga and Limpopo provinces of South Africa consume mature leaves, but in northern KwaZulu-Natal they eat shoot apices.

The bitterness of mature leafy shoots in *uMpampini oluhlaza* landraces might result from the dominance of anti-herbivorous tetracyclic terpenoid called cucurbitacin, which is genetically controlled. The dominant *Cu* and recessive *cu* alleles are responsible for high and low contents of cucurbitacin in cucurbits, respectively [21, 26].

Communities of northern KwaZulu-Natal preferred *isiPhama*, *uMpampini oluhlaza* and *uMpampini ophuzi* landraces based on the taste and texture of their cooked fruits. Taste preference of *Cucurbita* cultivars concurs with the report by Gajewski et al. [27]. Although these landraces were the most preferred ones, their poor fruit yield requires studies that will improve fruit yield for large scale farming.

5. Conclusion

Seven distinct *Cucurbita* landraces, which varied mainly on their vegetative and reproductive features, were identified. These variations, after confirmed with genetic analysis, might form basis for future breeding of such income-promising and hunger alleviating landraces. Assessment of genetic variation among these landraces is necessary to add on documented *Cucurbita* germplasm in South Africa. This work reported for the first time the existence of *Cucurbita argyrosperma* in this country. Further studies are necessary to maximize growth and yield of *C. argyrosperma* (*isiPhama*), *C. maxima* (*uMpampini oluhlaza*) and *C. maxima/pepo* (*uMpampini ophuzi*) landraces which are the most preferred landraces.

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