Identification And Selection Of Superior Phenotypes Of *Uapaca Kirkiana* Muell Arg. (Euphorbiaceae), A Priority Indigenous Fruit Tree Of Zimbabwe

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Abstract

The International Centre for Research in Agroforestry (ICRAF now known as the World Agroforestry Centre) initiated research and development work on at least 20 priority indigenous fruit trees in 5 countries in Southern Africa including Zimbabwe. The long term objective of this work was to improve food security and income generating capacities of local communities through domestication, marketing and commercialisation of indigenous fruit trees. Country specific priority species were identified based on consultations with a wide range of users. For Zimbabwe, *Uapaca kirkiana* emerged as a priority species with economic potential and has since become the focus of intensive research. A study aimed at identifying and selecting superior phenotypes of *U. kirkiana* was initiated in six districts of Murehwa (Natural Region I), Goromonzi (Natural Region II), Rusape (Natural Region II), Bindura (Natural Region II), Masvingo (Natural Region III) and Gokwe (Natural Region IV). Participatory Rural Appraisal (PRA) techniques in the form of group discussions amongst researchers, extensionists, school children, vendors and processors led to the identification of 48 trees of superior

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phenotypes. Tree location and altitude were recorded using the Geographical Positioning System (GPS). Fruit size, colour, shape were recorded. Total Soluble Solutes (TSS %) was measured using a hand refractometer. The largest fruits (42.3 g/fruit) were collected from Gokwe (ICR03GokZW41) whilst the smallest fruits (9.1 g/fruit) were collected from Rusape (ICR03RusZW53). Fresh fruit weight was strongly correlated to the seed weight ($r = 0.813$). Fruits with higher pulp content had a lower seed weight ($r = -0.452$). Fruits from Gokwe and Masvingo had higher TSS percentage. Basing on stakeholders' selection criteria and laboratory analysis, 23 trees above the mean fruit weight (20.63 g/fruit) were classified as large, whilst 24 trees with pulp content above the mean of 45.18% were classed as pulpy and 22 trees with TSS above 19.53% were classed as sweet. Similarity of the phenotypes was determined through complete linkage in hierarchical cluster analysis. Clustering confirmed the characterisation by farmers using taste as a key method of selecting suitable phenotypes. *In-situ* conservation and establishment of clones from the selected trees is recommended for purposes of commercialising these superior phenotypes.

Keywords: cluster analysis, fruit, pulp, size, selection, TSS%

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1 Introduction

Uapaca kirkiana Muell Arg. (Euphorbiaceae) is one of the most important fruit trees native to the Miombo ecological zone of Southern Africa (Ngulube et al. 1995). The tree is reported as a priority species in Zimbabwe, Zambia, Malawi and Tanzania. *U. kirkiana* is a small to medium sized tree of up to 5-12m height. It has a characteristic rounded crown and mainly occurs at medium altitudes in open woodland. It is dominant on gravely soils. The stem bears short and thick branches with simple alternating leaves arranged in clusters. *U. kirkiana* is a dioecious that bears male and female flowers on separate plants. The male and female flowers are yellow green in colour and globose in shape (Ramadhani 2002; Ngulube et al. 1997). The fruits of *U. kirkiana* known as mazhanje or mashuku in Shona are spherical in shape with a rather hard skin surrounding an edible pulp. Flowers and fruits are set during the rainy season, and fruits mature from September to December (FAO. 1986). Fruits are collected for utilisation around the month of October to around February.

Although *U. kirkiana* is highly favoured for its edible fruit, the tree also provides several other services including medicine, fuelwood, timber, craftwood and shade. Most important however is the supplementary cash income generated from the sales of the fruit in rural and urban areas. A survey carried out in Zimbabwe showed that the fruits also contribute to household incomes besides contributing to the alleviation of food insecurity (Shumba et al.

2000).

Like other indigenous fruits, *U. kirkiana* plays an important role in household food security and nutrition, providing essential vitamins, minerals and calories (Saka 1995) for most rural communities in Zimbabwe (Kwesiga et al. 2000). *U. kirkiana* is an important source of food especially during periods of drought. The tree with its deep root system and deciduous nature can continue to produce fruit even when drought gives rise to a failure of traditional crops (Ngulube et al. 1995). The fruits, which are usually consumed fresh, are generally collected from the wild and from trees deliberately retained in the fields when forests are cleared for cultivation (Campbell et al. 1991).

The pulp of *U. kirkiana* fruits is also processed into a variety of products, which include alcoholic and non-alcoholic beverages, purees, jams and dried fruit leathers (Campbell 1987). Most of these products are processed and utilised at household level except for the jam which is manufactured at a commercial scale and sold at local and export markets.

U. kirkiana has great potential as a commercial, cash-generating tree for rural communities in Zimbabwe thus possibly reducing farmers' reliance on subsistence crop production (Rukuni et al. 1998). The tree has been prioritised for domestication and commercialisation in the Southern Africa region (Akinnifesi. 2004). *U. kirkiana* also emerged as one of the priority species targeted for intensive product development and commercialisation in a stakeholders' species and product prioritisation workshop conducted in this country in 2002 (ICRAF Annual Report 2003). To this date, numerous stakeholders (environmental, non governmental organisations, local and international research and development institutions, private companies, rural community groups) have since embarked on indigenous fruit based marketing and commercialisation activities where *U. kirkiana* is a species of major focus (Ham 2000).

Realising the socio-economic importance and market potential of specific indigenous fruit trees, the World Agroforestry Centre (ICRAF) initiated domestication of indigenous fruits of Southern Africa. In fact since 1997, ICRAF has conducted programmes that promote conservation and commercialisation of indigenous fruit trees in the region. The second phase (2002 - 2005) of the ICRAF project on indigenous fruit trees focuses on domestication and commercialisation of selected species. The key activities of this phase aimed at maximising impact through marketing and commercialisation of indigenous fruit trees and their products.

Since the inception of this project, ICRAF considered it essential to vegetatively propagate superior phenotypes in order to conserve and utilise their qualities. In the work reported in this paper, a participatory approach was used for identifying and selecting superior phenotypes of *U. kirkiana* from seven districts in the country. The main objectives of the collection missions were:

1. To document farmers' evaluation criteria of superior trees and to use the information during germplasm collection missions.
2. To identify and select superior mother trees of *U. kirkiana* for mass clonal multiplication and fruit production.

2 Methodology

2.1 Identification of *U. kirkiana* growing areas

In order to identify major *U. kirkiana* natural stands, consultations were held with extension workers, Forestry Commission, farmer key informants, school children, vendors and traders.

Information about source areas and desirable traits for fresh consumption and for processing into various products were collected from workshop participants using a checklist and a structured survey questionnaire administered during village workshops and interviews held in the respective areas.

Table 1: List of villages selected for identification and selection of superior phenotypes of *U. kirkiana*.

District	No. of Sites / Villages	Natural Region	No. of trees evaluated
Goromonzi	4	IIa	4
Murehwa	4	I	7
Masvingo	3	III	9
Bindura	1	III	7
Gokwe	1	IV	7
Rusape	1	IIb	14

Collections began in Murehwa and Goromonzi where the communities had been reported to protect *U. kirkiana* stands for socio-economic reasons. As more information became available during the process of tree selection and acquisition of knowledge on the species, five other sites were identified. The selected sites covered all agroecological zones of the species natural distribution. Six districts Murehwa (Natural Region I), Goromonzi (Natural Region II), Masvingo (Natural Region III), Bindura (Natural Region III), Rusape (Natural Region II) and Gokwe (Natural Region IV) were identified for collection of superior phenotypes of *U. kirkiana*.

Fourteen villages in all the six districts were selected for the collections (Table 1). Factors considered in selection of sites included, availability and abundance of trees in the area, interest in the project and willingness of the communities to participate. In any case, a minimum distance of 100m between selected trees was maintained. Among the districts selected were areas in which ICRAF had already initiated some on farm research activities.

A total of 180 trees were identified in 14 villages but fruits from only 48 trees were evaluated for their physical and chemical properties. The other trees did not have fruits available at the times of collection.

2.2 Identification and selection of superior phenotypes

The identification and selection of trees was a farmer led participatory exercise with Forestry Commission and Government extension workers as part of the expedition. In each respective district, discussions were held with key informants representing different categories of stakeholders i.e. farmers, traders, processors and schoolchildren. For the six districts, a total of 160 female and 96 male farmers, 45 female and 30 male fruit vendors and 65 female and 65 male school children participated in the workshops. Interviews where information was collected using a set of guided checklists and participatory rural appraisal (PRA) techniques was done.

Information about history of trees, management, utilisation, diversity and farmers criteria for selecting superior phenotypes of *U. kirkiana* and their preferences were noted. Consensus was reached amongst the participants to list the most important criteria for selecting superior trees.

Selected trees were observed jointly by the participants and assessed for final selection. Tree location and altitude were recorded using Geographical Positioning Systems (GPS). Tree attributes such as height, diameter at breast height (DBH), crown shape and size were also recorded using conventional horticulture and forestry techniques (Paudel et al. 2002).Selected trees were marked with white paint and given an identity number.

2.3 Collection and evaluation of fruits from selected mother trees

During the summer periods from December 2002 to March 2003, and from November 2003 to February 2004 a total of 180 trees were identified as ”candidate” superior trees. Only ripe undamaged fruits, which had fallen to the ground, were collected. Sixty fruits were randomly collected from each tree and packed into paper bags. These samples were labelled and stored in a cold room until their evaluation.

2.4 Evaluation of physical properties of fruits

Fruit size was determined by averaging the weight of twenty fruits randomly picked from the collected fruits. To determine pulp, seed and skin content, the components were carefully separated and then subsequently weighed and expressed as a percentage.

2.5 Evaluation of chemical properties of fruits

Total soluble solids (TSS %) content was measured using a hand refractometer in Brix (%). Twenty randomly selected fruits were analysed for TSS content and readings were averaged for the final record for each tree. A dendrogram was produced using single linkage method. Euclidean distance for cluster analysis was used (Fry 1991).

Selected trees were first ranked for each of the individual criteria in order of participants' preference. Multiple criteria were used to select the best candidate trees from those that were ranked well than the mean value for each of the criteria used. Simple descriptive statistics, one-way ANOVA and non-parametric correlation were used for analysis using Genstat Release 7.1 (2003) statistical package. Average linkage clustering of *U. kirkiana* using chemical analysis properties was done. A dendrogram was produced using single linkage method. Similarities between trees based their fruit chemical properties by hierarchical clustering was determined using Genstat Release 7.1 (2003) statistical package.

3 Results

3.1 Evaluation of physical traits of fruits from selected trees

The major characteristics, which were said to determine the superiority or inferiority of *U. kirkiana*, were fruit size, pulp content, sweetness and quantity of fruit produced per tree. As a result, selection of superior trees was primarily based on these criteria. Participants agreed that internal characteristics like sweetness, pulp content, pulp texture and pulp colour were important. In addition, seasonality of fruiting and general appearance of the fruit (skin and pulp colour, skin texture and fruit shape) were also considered as significant characteristics in determining superiority.

Appearance of the fruit (mainly size and colour) was cited as the major physical attribute affecting choice of fruits for the fresh market. Vendors and traders preferred fruits, which were round in shape, with a yellowish brown colour and a smooth skin. It was reported that such fruits were attractive, easier to package and market. These traits were thus noted as useful in selecting trees for fresh fruit production. However, all participants argued that external properties of the fruits were poor indicators for internal characteristics like taste or sweetness, which are valued by processors and consumers.

U. kirkiana fruits were generally said to be sweet fruits. Those with a ”tangy and sweet” taste were said to be quite superior but very rare. The two types were recommended as the best for fresh fruit consumption and processing into purees, beverages, as they would not need additional sugar. A considerable amount of sugar would however be required for jam making. Additional attributes for processing at both household and commercial levels were pulpiness and a bright yellow attractive pulp.

It was noted that participants did not perceive physical tree attributes as important in selecting superior trees. This could probably be due to that ripe *U. kirkiana* fruits are collected after they drop to the ground naturally thereby removing the need to climb to harvest the fruits. Their sentiments however do not eliminate the need for considering tree architecture while developing trees for domestication and commercialisation. The effects of tree attributes such as height, canopy spread and depth on the quantity and quality of fruits have yet to be fully investigated and verified. It is therefore assumed that horticultural practices like tree spacing; pruning and training of branches might become useful recommendations for orchard production for these indigenous fruit species.

A general agreement on selection criteria for superior quality fruit production was reached among farmers, fresh fruit traders, consumers and processors. Trees were considered superior when they possessed all or at least three of the following traits; high yield, large fruits, high pulp content, sweetness, bright yellow pulp, attractive appearance, pest and disease free. The ranking of these characteristics varied amongst the different categories of stakeholders.

Fresh fruit vendors and traders preferred early and late maturing trees, which produce large quantities of attractive fruit and sold for competitive prices. Fresh fruit consumers, who buy only a few quantities of fruit, observe first the external qualities (size, skin colour) of the fruit and then enquire about the internal properties of the fruit (sweetness, taste, pulp colour and pulp content). Processors were mainly concerned with high pulp recovery and high sugar content for processing.

Table 2: Characteristics of the identified superior phenotypes of *U. kirkiana*[‡].

Tree No	District	Tree ID	Key reasons for selecting	Fresh weight (g)	Pulp content (%)	TSS (% brix)
1	Goromonzi	ICR02GorZW1	Fruits twice, very sweet	23.3	40.1	17.1
2		ICR02GorZW2[abc]	Very sweet	28.6	53.6	21.6
3		ICR02GorZW3	Very sweet, heavy bearer	24.2	43.7	19.2
4		ICR02GorZW4	Very sweet	29.1	37.5	19.4
5	Murehwa	ICR02MurZW6[abc]	Pulpy, very sweet, very big	23.5	55.0	22.8
6		ICR02MurZW8[abc]	Pulpy, very big, very sweet	33.0	52.9	24.0
7		ICR02MurZW9	Very big, heavy bearer	33.5	19.6	19.3
8		ICR02MurZW10	Very big, heavy bearer	22.0	41.3	15.4
9		ICR02MurZW11	Juicy, very big	20.0	50.2	19.9
10		ICR02MurZW12	Fruits twice, tangy and sweet, very big	29.0	57.3	19.2
11		ICR02MurZW7[b]	Pulpy, very big, very sweet	20.5	50.2	22.5
12	Masvingo	ICR02MasZW18[ab]	Very tasty, heavy bearer	21.9	54.5	23.6
13		ICR02MasZW20	Very sweet	21.3	18.4	17.6
14		ICR02MasZW23	Pulpy	17.4	53.2	20.0
15		ICR02MasZW25[abc]	Very sweet, heavy bearer, early	26.0	56.3	22.5
16		ICR02MasZW26	Very sweet, very firm	16.4	45.5	24.4
17		ICR02MasZW28	Pulpy, very big, very sweet	14.7	54.8	25.6
18		ICR02MasZW29	Very sweet, heavy bearer	14.0	55.6	27.0
19		ICR02MasZW30	Very sweet, heavy bearer	17.4	60.0	18.8
20		ICR02MasZW31[abc]	Very sweet	20.9	54.4	24.9
21	Bindura	ICR03BinZW32	Sweet	17.0	36.6	21.0
22		ICR03BinZW35	Very tasty	17.8	42.5	16.8
23		ICR03BinZW36	Very tasty	25.1	37.2	18.9
24		ICR03BinZW37	Very tasty	28.9	49.4	18.4
25		ICR03BinZW38[abc]	Very sweet	25.0	41.8	22.8
26		ICR03BinZW39a	Very sweet	26.5	47.0	18.0
27		ICR03BinZW41[abc]	Pulpy, very sweet	29.8	52.9	22.5
28	Gokwe	ICR03GokZW41	Fruits twice, very sweet	42.3	57.5	17.1
29		ICR03GokZW42[abc]	Fruits twice, very sweet	24.9	59.9	20.0
30		ICR03GokZW43	Fruits twice, very sweet	16.4	46.8	24.3
31		ICR03GokZW44[abc]	Very sweet	21.3	45.9	21.9
32		ICR03GokZW47	Fruits twice, pulpy	16.3	51.2	24.4
33		ICR03GokZW51	Fruits twice	19.0	35.6	10.7
34		ICR03GokZW52	Fruits twice, very sweet, very big	14.9	40.0	24.3
35	Rusape	ICR03RusZW53	Very sweet, very tasty	9.1	32.2	21.1
36		ICR03RusZW54	Very tasty	17.4	39.3	16.5
37		ICR03RusZW55	Pulpy	17.6	47.0	13.6
38		ICR03RusZW56	Very tasty	11.6	39.8	13.7
39		ICR03RusZW57	Very tasty	14.0	40.5	13.0
40		ICR03RusZW58	Very tasty	13.0	37.2	17.1
41		ICR03RusZW59	Very sweet	13.7	41.9	16.8
42		ICR03RusZW60	Very sweet	15.5	40.5	15.6
43		ICR03RusZW61	Very tasty	13.5	42.4	14.0
44		ICR03RusZW62	Very tasty	13.5	35.7	17.6
45		ICR03RusZW63	Very big	23.1	50.0	16.7
46		ICR03RusZW64	Very big, very pulpy	22.0	41.4	15.1
47		ICR03RusZW65	Very tasty	13.6	43.9	10.4
48		ICR03RusZW66	Very tasty	10.7	38.9	23.3
	MEAN			20.63	45.18	19.53

[‡]Trees marked *a* classified as large and sweet; *b* - classified as pulpy and sweet, *c* - classified as large, pulpy and sweet

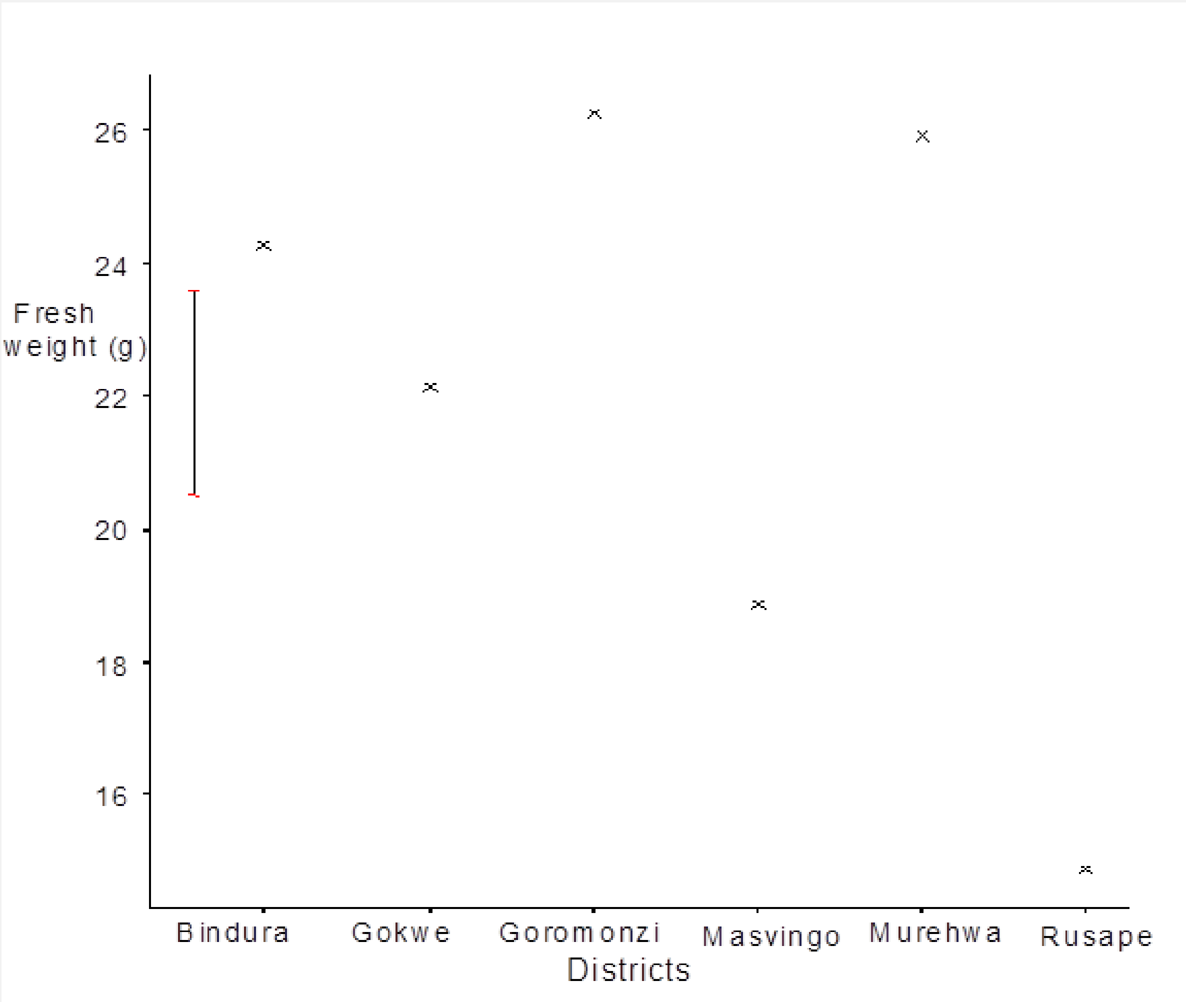

Figure 1: Average fruit weight (g) of *U. kirkiana* collections

3.2 Evaluation of physico-chemical properties

3.2.1 Fruit size

The size of fruits in terms of average weight of fruit (Figure 1) differed significantly amongst the districts ($p < 0.01$) and within sites (Table 2). Fruits with the highest average fresh weight, ICR03GokZW41 (42.3g/fruit) were recorded in Gokwe District whilst those with the lowest average fresh weight (9.1 g/fruit) were found in Rusape. However, the average for Gokwe district was lower than that of Bindura, Goromonzi and Murehwa. Most trees from Rusape had significantly smaller fruits (< 20.63 g/fruit - mean for fresh weight) than those from other sites. It was observed that fruits, which were selected in a particular site on the basis of their "big size", were not in fact comparatively larger than their counterparts from other trees or sites. This confirms that criteria based on subjective assessment alone cannot be used to characterise and select phenotypes.

The fruit weight was positively correlated ($r = 0.562$) to the seed weight. Similarly, fruit fresh weight was also found to be strongly correlated ($r = 0.813, p = 0.01$) to the seed weight. There was however a positive but non-significant correlation ($r = 0.234$) between fresh weight and pulp content. The results indicated that larger fruits had higher seed weight, shell weight and pulp content.

3.2.2 Pulp, skin and seed weight

Pulp content did not vary significantly within and between the sites ($p = 0.208$). It ranged from 18.42% (tree ICR02MasZW20) to 60% (tree ICR02MasZW30) with a mean of 45.18% being recorded. The results are highlighted in Table 3.

Table 3: Pulp content averaged across sites.

Site	Mean pulp content (%)	N
Rusape	40.8	14
Goromonzi	43.7	4
Bindura	43.9	7
Murehwa	46.6	7
Gokwe	48.1	7
Masvingo	50.3	9
Mean	45.2	48
CV (%)	20.31	

Table 4: Average TSS (%) measured across sites.

Site	TSS (%)	N
Rusape	16.04	14
Goromonzi	19.32	4
Bindura	19.77	7
Gokwe	20.39	7
Murehwa	20.44	7
Masvingo	22.41	9
Mean	19.38	48
CV (%)	20.54	

3.2.3 Total soluble solid (TSS) content

Total soluble solids, a factor determining sweetness varied from 10.4% to 27.0% with a mean of 19.53% at the time of collection. Fruits from Masvingo and Gokwe contained significantly higher TSS when compared with fruits from other sites (Table 4). There was also strong evidence of differences in TSS content amongst sites ($p = 0.001$). For the selected trees that farmers considered very sweet, they indeed contained higher TSS and the same was true for pulp content. There was a positive correlation ($r = 0.369$) between TSS and pulp content.

3.3 Cluster analysis

The clusters formed showed that TSS (%) is the most critical factor in determining clusters between trees from different districts. The clusters are highlighted on Figure 2. Rusape trees maintained similarity in the dendrogram. The preferred trees by farmers were clustered together confirming their similarity due to tasting criterion. For the selected trees, another clustering process was done and it indicated 3 major clusters (Figure 3). Clustering indicated that districts was not a critical factor in determining similarities.

3.4 Multi-trait assessment

Based on participants' selection criteria and laboratory analysis, the major factors considered in choosing superior phenotypes were fruit size and TSS. Statistical means for these factors were used to determine the best candidate trees. Twenty three trees with fresh weight above the mean (20.63g) were classified as large, whilst 24 trees with pulp content above 45.18% were described as pulpy and 22 with TSS above 19.53% were classified as sweet. Nine of these qualified for large, pulpy and sweet, whilst 11 qualified for pulpy and sweet. Trees

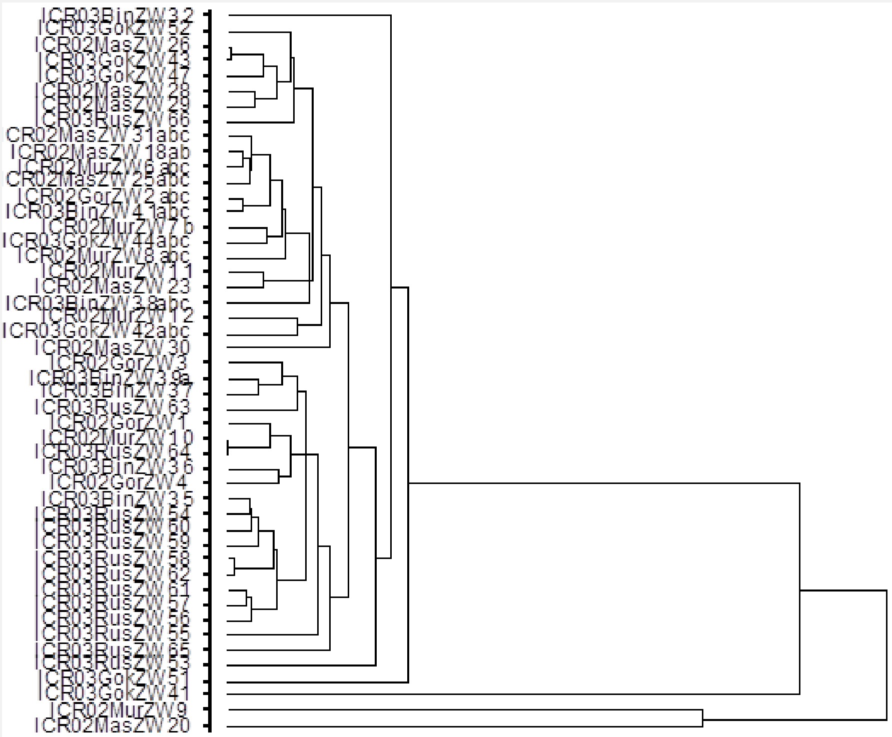

Figure 2: Dendrogram of the cluster analysis of different phenotypes.

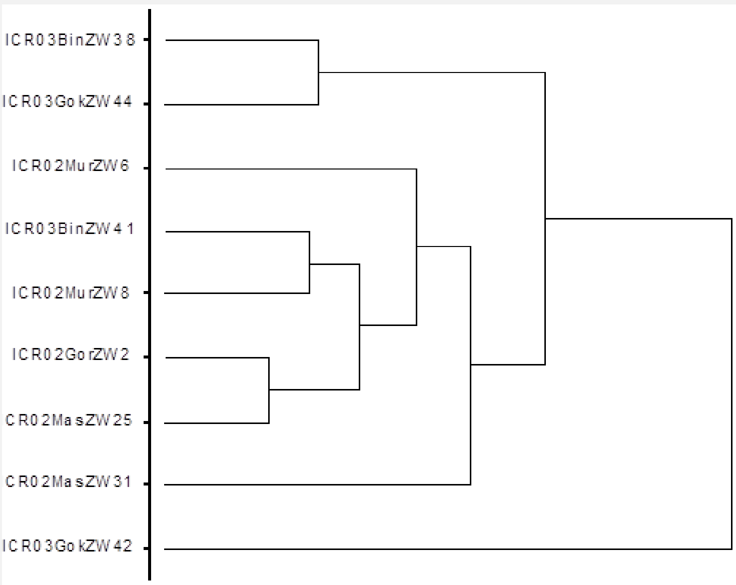

Figure 3: Dendrogram of the cluster analysis of superior phenotypes.

with values above means for each of the traits were considered for multi-trait selection.

A total of only 9 trees satisfied the 3 most important criteria determining superiority (size, pulp content, brix %). Table 5 shows the trees, which were selected according to big size, high pulp content and high sugar content. This set of trees will therefore be used as candidate trees for clonal propagation.

Table 5: Characteristics of the trees selected for multiple criteria.

District	Tree ID	Village	Fresh weight (g)	Pulp content (%)	TSS (% brix)
Bindura	ICR03BinZW38	Nyava	25.0	41.8	22.8
Bindura	ICR03BinZW41	Nyava	29.8	52.9	22.5
Goromonzi	ICR02GorZW2	Ngazimbi	28.6	53.6	21.6
Gokwe	ICR03GokZW42	Mafa	24.9	59.9	20.0
Gokwe	ICR03GokZW44	Mafa	21.3	45.9	21.9
Masvingo	ICR02MasZW25	Chikume	26.0	56.3	22.5
Masvingo	ICR020MasZW31	Uranda	20.9	54.4	24.9
Murehwa	ICR02MurZW6	Chadenga	23.5	55.0	22.8
Murehwa	ICR02MurZW8	Chimani	33.0	52.9	24.0
Mean			25.89	52.52	22.56
Variance			15.83	29.83	1.95
Cv%			15.37	10.40	6.19

3.5 Conservation of selected phenotypes

3.5.1 In-situ conservation

All selected have been marked, numbered and are protected in situ by selected community members in the respective areas. Most of the trees are near homesteads and some stand in forests. Although the farmers are aware of the importance of these marked trees, they however can not be obliged to protect the tree forever, hence the trees are subject to their needs be it for house hold utilisation and income generation. It is suggested that concerned national programs and organisations maintain the trees records and discuss rights and ownership of these trees with the concerned communities and individuals.

3.5.2 Establishment of Clonal Orchard

A clonal orchard comprising 30 seedling rootstocks of *U. kirkiana* has been established at the experimental station at Domboshava - Zimbabwe. Scion from the set of selected trees will be grafted onto these rootstocks. Consequently the trees will be used as mother trees for producing materials for distribution and for research and also for tissue culture. In the future, the clonal orchard may be expanded to include more trees from other districts.

4 Discussion

The socio-economic importance and market potential of *U. kirkiana* a priority indigenous fruit tree species in Zimbabwe cannot be underestimated. The efforts by ICRAF and other stakeholders to domesticate and commercialise this species clearly demonstrates this importance. Also notable is the strong participation by local communities in key activities i.e. species and product prioritisation, selection and identification of superior phenotypes, contribution to the documentation of indigenous technical knowledge (ITK) on indigenous fruit trees (IFTs). Communities have clearly demonstrated a vested interest in IFTs, which play an important role in household nutrition, food security and income generation. Rural communities may probably have come to realise the comparative advantage of IFTs over field crops and may therefore be eager to participate in programmes that promote conservation of fruit species more so because of the commercialisation potential associated with the trees and their products (Franzel et al. 1996).

The ICRAF-Zimbabwe project on Domestication and Commercialisation has covered considerable milestones towards commercialisation IFTs. The first phase of the project resulted in the development and optimisation of methods for vegetative propagation of priority species including *U. kirkiana*. In Malawi, the protocols have since been used as routine methods for producing grafted *U. kirkiana* trees which fruit as early as 3 years. In addition a provenance trial to evaluate 12 provenances of *U. kirkiana* was established in 1997. The trial is still in progress with none of the provenances yet. Until results from this trial can enable evaluation and selection of superior provenances, participatory selection of superior phenotypes and grafting onto seedling rootstocks was considered an appropriate alternative. This exercise is expected to accelerate the production of superior phenotypes of *U. kirkiana* for research purposes and for wide scale distribution. Consequently the planting of *U. kirkiana* trees of selected and preferred characteristics will be practised.

Leakey et al. (2000) suggested that the identification of trees combining a few other traits than many superior traits (ideotypes) approach is preferable to create cultivars for a particular purpose. In this work, trees with large and sweet fruits may be profitable for the fresh market whilst also suitable for the processing sector. Similarly, the large, pulpy and sweet fruit are also suitable for both fresh markets and processing. The non-significant correlation between key traits like fresh weight and pulp content may also indicate an inadequate sample size.

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