

**UTILIZATION OF PLANT FUNCTIONAL TRAITS IN MITIGATING OVER-  
EXPLOITATION OF HIGH ETHNOBOTANICAL VALUE PLANTS OF CHONGWE  
DISTRICT, ZAMBIA.**

**BY**

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the award of Master of Science in Tropical Ecology and Biodiversity**

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## DECLARATION

I **MWAMBO MATTHEWS** do here by declare that the work presented in this dissertation is original and my own, and that all the works of other persons have been duly acknowledged. The work has not been previously presented at this University or indeed any other for similar purposes.

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## CERTIFICATE OF APPROVAL

This dissertation of **MWAMBO MATTHEWS** is approved as fulfilling part of the requirements for the award of the degree of Master of Science in Tropical Ecology and Biodiversity of the University of Zambia.

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## ABSTRACT

Traditionally valued wild indigenous plants play a critical role in various ethnic groups. Ethnobotanical value of plants differ according to the regions and ethnic groups. Despite the rich ethnobotanical value of tropical plants, there is still limited knowledge and no documentation on specific plant species use in Chongwe district. Besides, little effort has been made to cultivate them *ex-situ* or *in-situ* in Zambia leading to their decline. This may be due to limited knowledge in indigenous plant regeneration bringing about a challenge in optimizing their germination that can help in their restoration. Studies have shown that ethnobotanically valued plants are susceptible to over-harvesting leading to a reduction in plant abundance. This research, therefore, sought to highlight the plant species of high ethnobotanical value and study the effect of fruit weight, seed shape and seed depulping on seed germination and seedling emergence to propose optimal methods in improving seed germination performance. Ethnobotanical data was collected using convenience and snowball sampling methods. Semi-structured questionnaires were administered to fifty informants. Interviews were conducted in Nyanja, Bemba and English depending on the preference of the informants. Local names and the uses of the plant were recorded. It was found that most of the plant species in Chongwe were used for medicine purpose (33.6%) and Fabaceae emerged as the most used plant family. Out of the twenty most ranked native species in terms of cultural value, eight fruiting species of highest ethnobotanical value were exposed to experimentation to determine whether variables (fruit weight and seed shape) and treatments (depulped not washed and depulped washed) affected germination performance from August 2020 to January 2021. A stratified randomized design layout was used to place seed pots in the plant shed in the Department of Biological Sciences for an even

distribution of environmental parameters among treatments and to eliminate bias. Primary ethnobotanical data obtained from questionnaires was analysed using Excel while the experimental analysis on germination performance was done using Statistical Package for Social Science (SPSS). This study showed that seedling emergence were significantly affected by seed shape ( $P < 0.05$ ) as seedling emergence reduced from spherical to spindle seeds Germination rate was significantly affected by fruit weight ( $P < 0.01$ ) with a negative correlation coefficient of (-1.000) as germination rate increased with the reduction in fruit weight. Depulping and washing of seeds had a significant effect on germination percentage ( $P < 0.05$ ) with 61.5% depulped washed seeds germinating. Germination percentage increased significantly for the depulped washed seeds compared to the pulped (13.5%) and depulped not washed seeds (25%). Therefore, selecting seeds from smaller fruits and spindle shaped seeds of the studied species and as well as depulping and washing the seeds can give a high germination percentage. This can contribute to sustainable management of ethnobotanically valued species.

**Keywords:** *Ethnobotanical values; Plant functional traits; Seedling Emergence; Germination Rate; Germination Percentage.*

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## **LIST OF ABBREVIATIONS / ACRONYMS**

FC.....Frequency of Citation

RFC<sub>s</sub> .....Relative frequency of citations

RI.....Relative importance index

CV.....Cultural value index

CI.....Cultural importance index

P.....Pulped

DP.....Depulped Washed

DNW.....Depulped Not Washed

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## CHAPTER ONE

### INTRODUCTION

#### 1.1 BACKGROUND

Cultural and practical value of plants differ across regions depending on the culture and knowledge of plant use within a particular ethnic group. Plant uses can be grouped into different use categories such as medicine, human food, animal food, ornamental, toxic, energy source, signs, and craft and technology. Over-exploitation of plant species has threatened the existence of high value ethnobotanical plant species (Shumba *et al.*, 2009) by accelerating the ecological fragmentation of most natural forests as it creates imbalance between the rate of harvesting and the rate of replacement. Ethnobotanically important plant species are susceptible to over-exploitation due to their high demand to meet human needs (Nigro *et al.*, 2004). It is therefore necessary to explore the possibility of mitigating over-exploitation of the plant species by applying technological development strategies such as fruit weight and shape optimization as well as depulping and washing of seeds.

Therefore, understanding the effect of plant functional traits on seed germination and seedling emergence is critical for the restoration of these plant species and consequently stabilization of the ecosystem. This includes understanding germination and dormancy which is important in areas such as agriculture with regard to weed control, restoration ecology in degraded habitats and forestry with respect to re-establishing stands of native species (Baskin and Baskin, 2003; Pritchard, 2000). Seed germination and seedling emergence being a very important aspect of vegetation structure needs to be monitored with respect to plant functional traits at play. Plant functional traits are important in the reproductive biology of plants, which vary dramatically

across and within plant species (Hoyle *et al.*, 2015). With the need to restore threatened plant species of ethnobotanical value, ecologists need to establish the relationship of plant traits to germination for the predictive outlooks on their effects.

The goal of this study was to investigate the ethnobotany of some important plant species of Chongwe district and determine how germination performance (potential) is affected by their functional traits. The study employed both a survey which highlighted the ethnobotanically important plant species of selected villages of Chongwe and their different uses, and an experimental approach that provided germination strategies of selected plants with high cultural value index (CV). It was found that most of the plant species in Chongwe were used for medicine purpose (33.6%, Table 2) and Fabaceae imaged to be the most used plant family (Figure 5).

The experimental approach examined the effects of two variables (fruit weight and seed shape) on seedling emergence (the time taken for the first shoot to appear from the time it was sown), germination rate (the number of seeds germinating per germination period) and germination percentage ( $\text{Number of total germinated seeds} / \text{Total number of seeds tested} \times 100$ ) of eight highest ranked species in terms of cultural value index (CV) of indigenous plants of Chongwe district. It was found that Germination rate was significantly affected by fruit weight ( $P < 0.01$ ) with a negative correlation coefficient of (-1.000) as germination rate increased with the reduction in fruit weight. Depulping and washing of seeds had a significant effect on germination percentage ( $P < 0.05$ ) with germination percentage of 61.5% as germination percentage increased significantly for the depulped washed seeds compared to pulped (13.5%) and depulped not washed (25%). This means that considering treatment, fruit weight and seed shape, germination

performance of wild plants can be improved which can lead to sustainable management of ethnobotanically valued species.

### **1.3 PROBLEM STATEMENT**

Plants have multiple values in the ecosystems which stabilizes the ecosystem functions. Despite the rich ethnobotanical value of tropical plants, there is still limited knowledge and no published data on the various uses and most used plant species in Chongwe district. Moreover, despite a few studies on ethnobotanical properties of plants in Zambia (Chinsembu *et al.*, 2018; Compound *et al.*, 2018; Shumba *et al.*, 2009), there has been no inclusion of plant regeneration strategies on ethnobotanically important plant species. Furthermore, despite the documented various uses of plants in Chongwe district (Goma *et al.*, 2017) there has been no ranking of ethnobotanically used plants based on their values to determine the priority species with the highest exploitation pressure. Therefore, this study has documented cultural valued plants of Chongwe and ranked them based on their ethnobotanical values and has generated information useful for formulating conservation strategies for such selected traditionally used plants. The study will enhance ecological restoration of plant communities as it has highlighted the cultural valued species and provided their regeneration strategies. Moreover, little effort has been made to cultivate plants of high ethnobotanical value *ex-situ* or *in-situ* in Zambia (Shumba *et al.*, 2009) and there is limited knowledge of the regeneration parameters of these plants bringing about a challenge in optimizing their germination that can help in their conservation. Moreover, plants of high cultural value are susceptible to over-harvesting which is likely to lead to their reduction. Among the plants of high cultural value are medicinal plants which are most over-harvested, threatening their existence. These plants are also harvested for other uses such as energy

production and timber. This exacerbates the threat to their existence affecting the livelihood of local people who depend on them for their existence.

## **1.4 OBJECTIVES OF THE STUDY**

### **1.4.1 GENERAL OBJECTIVE**

- To investigate the ethnobotany of important plant species of Chongwe district and determine the effect of their functional traits on germination performance.

### **1.4.2 SPECIFIC OBJECTIVES**

1. To determine the ethnobotanical value of selected plants of medicinal and other uses in Chongwe.
2. To evaluate the effects of fruit weight on seed germination and seedling emergence.
3. To determine the effects of seed shape on seed germination and seedling emergence.
4. To determine the effects of seed depulping and washing on seed germination and seedling emergence.

## **1.5 HYPOTHESES;**

1. Plants with local medicinal uses have the higher ethnobotanical values than other plant uses in Chongwe district.
2. Increase in fruits weight increases seed germination and seedling emergence.
3. Spindleness of seeds increases seed germination and reduces seedling emergence.

4. Seed depulping and washing improves seed germination and seedling emergence.

## **1.6 JUSTIFICATION OF THE STUDY**

Natural forests have values that sustain other biodiversity including humans. Over-exploitation and fragmentation of native vegetation areas, and the natural resources they offer have attracted scientific research to focus their attention on the restoration of areas and priority species for the conservation. The pure ethnobotanical documentation of plant use alone, does not contribute much to conservation efforts. Therefore, knowledge of ethnobotanical values of plants when combined with functional ecology by understanding the effects of plant functional traits on seed germination and seedling emergence of traditionally valuable plants can improve management of these plants (Bussmann, 2002). By virtue of functional traits providing a general extrapolation over seed germination and seedling emergency, this study will importantly be applied in the regeneration events of plant restoration in Zambia and globally. It will enable the multiplication of indigenous plants of ethnobotanical value and shape the general ecosystem as some of these plants are formally being used internationally in health care systems through value addition and bio-trade (Shumba *et al.*, 2009). According to African Development Bank, (2003), international trade in medicinal plants was worth \$60 million and \$4.4 million in South Africa and Zambia respectively in 2003. Some of these plant species are declining due to over-exploitation (Shumba *et al.*, 2009). Moreover, many people rely on traditional medicine as they face economic challenges in seeking healthcare from public health facilities for themselves. Ethnobotanically important plant species have proven worth of conservation. Knowing the best regeneration strategies is one of the key to their conservation as some native plant species of importance are threatened with extinction due to exploitation by humans in the absence of bio-conservation

strategies. Therefore, this study documented the ethnobotanically valued plants of Chongwe district and determined methods of their regeneration *ex-situ* or *in-situ* for sustainable development. Since seed germination and seedling emergence are critical processes of tropical plant species, this information can be key for the management of ethnobotanically valued plant species in Zambia. Moreover, other plant seeds undergo dormancy due to their physiological and morphological traits that they exhibit and may take time to germinate and grow, hence understanding such traits may be a way of breaking the dormancy of such species.

## CHAPTER TWO

### 2.0 LITERATURE REVIEW

#### 2.1.0 Ethnobotany

More than 50% of the habitat has been destroyed in 49 of 61 world tropical countries original forest and woodlands (Primack and Morrison, 2013). Moreover, Miombo woodlands being the most extensive tropical woodland formation of Africa directly supports the livelihoods of over 100 million people through the provision of many tree products and ecosystem services essential to both the rural and urban communities (Syampungani *et al.*, 2009) of which about 80% of rural health depends on it.

Ethnobotany being a scientific discipline that highlights and documents the cultural use, level of use and frequency of use of plants by the local people, plays a critical role in the conservation of culturally valued plants. It also includes information about the ethnic groups that use the plants for various purposes (Soejarto *et al.*, 2009). However, ethnobotanists have struggled to gain the trust of the traditional peoples with which they work due to colonial context, where practice of traditional medicine is suppressed either through legal authorities (Soejarto *et al.*, 2009) or condemned as evil by Christians. Meanwhile, ethnobotanical fieldwork has led to increased data collection, both in terms of culture and botanical use of plants and has advanced in modern medicine and pharmacology that have allowed for more scientific research by identification of plants, isolation, and testing of bioactive chemical compounds found in them (Soejarto *et al.*, 2009). For example, Goma *et al.*, (2017) documented extraction and demonstration of uterotonic activity from the root of *Steganotaenia araliacea* Hochst in Chongwe and its medicinal uses.

These types of studies have led to the discovery of active compounds for 25% of all prescription drugs, hence there is little question as to the efficacy of ethnobotanical approaches to drug discovery. Almost 70% of the Zambian population depends on traditional medicine and traditional medicinal practices as a source of primary health care (Muyenga *et al.*, 2018).

Moreover, since ethnobotanical studies give conservation status of plants such as endangered, vulnerable, critically endangered, susceptible or rare (Panigrahi *et al.*, 2021), inclusion of sustainable conservation strategies and methods of propagation in ethnobotanical studies is important for sustainable management of natural resources. The study of ethnobotany in conjunction with conservation biology may be one of the keys for sustainable utilization and management of biodiversity. Despite the various studies on ethnobotanical values of plant species in Zambia (Chinsemu *et al.*, 2018; Goma *et al.*, 2017), there have been limited knowledge on their conservation strategies. For example Chinsemu *et al.*, (2018), looked at ethnomedicinal plants used by traditional healers in the management of HIV/AIDS opportunistic diseases in Lusaka, including parts of Chongwe, Zambia. In this study a number of plants were documented such as *Abrus precatorius* L., *Ziziphus mucronata* Willd, *Piliostigma thonningii* (Schumach.) Milne-Redh, *Dichrostachys cinerea* L. and *Combretum imberbe* Wawra. However, there was no suggested method of conserving them either *in-situ* or *ex-situ*. Without any regeneration methods of such useful plants, there is a threat to their sustainable use. Moreover, the study by Adeniyi *et al.*, (2018) showed that majority of human populations in developing countries rely on traditional medicines. However, 81% of the plants reported in the study were non-cultivated plants while 19% were semi-cultivated plants, and none were cultivated. Therefore, the most used plant species are prone to extinction and should be cultivated for

sustainable use (Shumba *et al.*, 2009). Knowledge of ethnobotanical values informs future plans for sustainable utilization and management of plant natural resources.

### **2.1.1 Ethnobotanical indices**

Regarding ethnobotanical value of the plant species globally, multiple studies have employed different kinds of indices in the assessment of ethnobotanical values of plants depending on the focus of the study. For example Chinsembu *et al.*, (2018) calculated the percentage frequencies, familiarity index ( $F_i$ ) factor informant consensus ( $F_{IC}$ ) is the total number of use citations in each ailment category minus the total number of species used, divided by the total number of use citations in each category minus one. Different quantitative techniques have been used in ethnobotany to compare the uses and ethnobotanical importance of different plant taxa. Critical evaluation of quantitative techniques in ethnobotany reflect scientific interest in plant taxa, as they are applied to compare the uses and the cultural importance of different plant taxa that can aid conservation of biodiversity (Albuquerque *et al.*, 2006).

On the other hand Tardío and Pardo-De-Santayana, (2008) compared the four indices used by most researchers: relative frequency of citations ( $RFC_s$ ), relative importance index (RI), cultural value index (CV), and cultural importance index (CI) to compare the importance of each species. They recommended the use of CI for comparative studies of the cultural importance of plants within and among different regions. However, CI is strongly correlated with the frequency of citation (FC) which measures the spread of knowledge about the plants. Cultural importance index (CI) considers diversity of use and each use-category which is conveniently weighed by the number of informants mentioning it. The RI index is the mean between the RFC and the

relative number of uses (RNU) which correlate with CV and is said to overweight the multiplicity of uses.

According to Tardío and Pardo-De-Santayana, (2008), even though CV gives excessive weight to diversity of use, it takes into account three indices (FC, RNU and CI). This index is amplified due to its multiplication of relative values of frequency of citation of the species (FC/N), number of uses (NU/NC), and number of use-reports (UR/N) giving more weight to diversity of use of plants corresponding to its practical value within an ethnic group (Tardío and Pardo-De-Santayana, 2008). This study determined the ethnobotanical value of selected plants of Chongwe by calculating the cultural value index.

Nevertheless, Reyes-García *et al.*, (2006) expressed contrasting ideas over the use of cultural value to represent the practical value of plants as they found a low correlation between the practical use and the cultural values of species. Reyes-García *et al.*, (2006) found that some species rarely used were frequently mentioned in interviews hence stating that the cultural value of a plant species obtained through interviews using a free-list method, does not necessarily correspond to its practical value within an ethnic group compared to using observational data as some are rarely used at present because they were exploited almost to extinction. However, in this study, the informants mentioned only the observed plants which qualifies the use of CV index to assess the ethnobotanical values in Chongwe.

Despite this contradictory ideology by Reyes-García *et al.*, (2006), it still means that plants of higher cultural value are susceptible to over-harvesting, deserving more local conservationist attention than those of lower cultural values. Therefore, CV is an appropriate index to use in this study.

## **2.2 Effects of functional traits on germination performance**

The issue of propagation of ethnobotanically valued species is important in the conservation of biodiversity. Seed germination has shown significant influence on community composition in response to climate change (Kimball *et al.*, 2010), in that plant trait differences can promote distinct survival and fecundity responses to environmental dynamics. In spite of the large number of studies concerning the effects of plant functional traits on seed germination and seedling emergence, it remains unclear to what extent seed morphology independently affects ecological characteristics such as germination and seedling performance.

### **2.2.1 Seed shape**

Previous studies have shown that germination success is positively related to seed shape. The study by Cosyns *et al.*, (2005) showed that slightly elongated (spindle) seeds reflect the higher relative germination success (probability) than round seeds. Seeds with a range of morphological characteristics, possibly related to germination success (differentiation in seed size, shape and mass) were chosen and seed shape was determined by measuring seed width and length without any of their appendices such as plumes, hairs or awns on 15 seeds. Tabakovic *et al.*, (2020), observed significant differences in seedling emergence between flat (spindle shaped) and round maize (*Zea mays* L.) seeds. Tabakovic *et al.*, (2020) categorized seeds into two fractions according to the seed shape: flat and round seeds and as they were looking at both seed size and seed shape six fractions were obtained: small flat seed, small round seed, medium small flat seed, medium small round seed, large flat seed, and large round seed. Seeds were exposed to two laboratory treatments: TR1 (cold test) and TR2 (20/30 °C). The highest total germination was recorded in TR2 (20/30 °C) of which flat fraction seeds had more rapid emergence (> 90%) of seedlings than the round fraction seeds (> 85%). Therefore, seed shape being a good predictor of

seedling emergence (Pakeman *et al.*, 2002) can be considered when improving the germination performance of seeds.

### **2.2.2 Fruit weight**

In terms of fruit weight, *Xanthium strumarium* L., showed strong positive correlation with seedling emergence and germination rate, although germination rate level off for larger fruits (Zimmerman and Weis, 1983). Zimmerman and Weis, (1983) sorted fruits by weight into eight size classes and germinated them in growth chambers. They found that larger fruits germinated to a higher percentage than smaller fruits while germination rate increased dramatically across the smaller fruit size classes but was essentially constant across larger size classes. This however, contrasted with Chama *et al.*, (2013) who found that fruit weight did not affect the seedling emergence time and germination percentage. This could be due to environmental dynamics between the areas of study or due to a wide range of fruit weight considered by Chama *et al.*, (2013) as Zimmerman and Weis, (1983) experimented on one species which could not produce a wide range of fruit weight.

### **2.2.3 Seed depulping and washing of seeds (Treatment)**

With regard to the effect of seed depulping Robertson *et al.*, (2006) found that manually depulped had a higher germination rate compared to intact fruits as the fruit pulp may be associated with potential germination inhibitors. Furthermore, Robertson *et al.*, (2006) and Amodeo *et al.*, (2017), contrasted with Chama *et al.*, (2013) by suggesting that rarely-measured deinhibition effect (germination of hand cleaned seeds against those in intact fruits) is another factor affecting seed germination as the fruit may contain some chemicals that may inhibit seed germination. Robertson *et al.*, (2006) classified the studies reviewed by the conditions used for germination trials such as laboratory, glasshouse or field. With these germination trials

deinhibition effects were measured on germination and dormancy under field conditions. Germination of hand-cleaned seeds were compared with seeds in intact fruits of another in three New Zealand tree species: *Nestegis cunninghamii* (Hook. f) L.A.S. Johnson (Oleaceae), *Pennantia corymbosa* J.R. Forst & G. Forst. (Icacinaceae) and *Melicytus lanceolatus* Hook. f. (Violaceae) which were chosen because they come from three different families with different fruit structures, and fruiting material. All the three were available at a single site. Germination percentages were found to be high in all conditions for hand-cleaned seeds as germination of seeds from intact fruits was generally slightly lower than for hand-cleaned seeds in the field and pots in the glasshouse, but germination from intact fruits in Petri dishes was zero for all three species. In consistent with Robertson *et al.*, (2006), Amodeo *et al.*, (2017) showed no signs of germination in the intact fruits, whereas the hand-peeled stones showed low germination values. This was consistent with Barnea *et al.*, (1991) who showed that out of 28 species, 14 were not affected by pulp removal, while in the other 14 cases germination increased significantly when depulped suggesting that some fruit pulp may not contain germination inhibitors while others may contain germination inhibitors respectively which was also observed by Amodeo *et al.*, (2017) as they could not make any solid conclusions about the inhibitory effects of the pulp. In *Prunus mahaleb* L., both pulped and depulped fruits presented similar high germination rates under semi-natural conditions. Izhaki and Safriel, (1990) also found that some fruits like morphs contain germination inhibitors, meaning that the removal of the pulp may increase the rate of germination.

## **CHAPTER THREE**

### **3.0 MATERIALS AND METHODS.**

#### **3.1 Study area**

The study was conducted in Villages of Chongwe district (Kampekete (15.37453, 28.71822), Kapamangoma (15.41109, 28.40931), Katende (15.34038, 28.60424), Mutanuka (15.38108, 28.60541) and Mwashinango (15.27511, 28.46322)) of Zambia. Chongwe district was chosen as a study area as it is a village setup where most people depend on plants for their livelihood and the alarming deforestation due to charcoal production (Chisola and Kuráž, 2016). Chongwe is situated in Lusaka province of Zambia (figure 1). It lies between latitudes 15°19'36" south and 15°20'25" south, and between longitudes 28°41'41" East and 28°39'49" East.

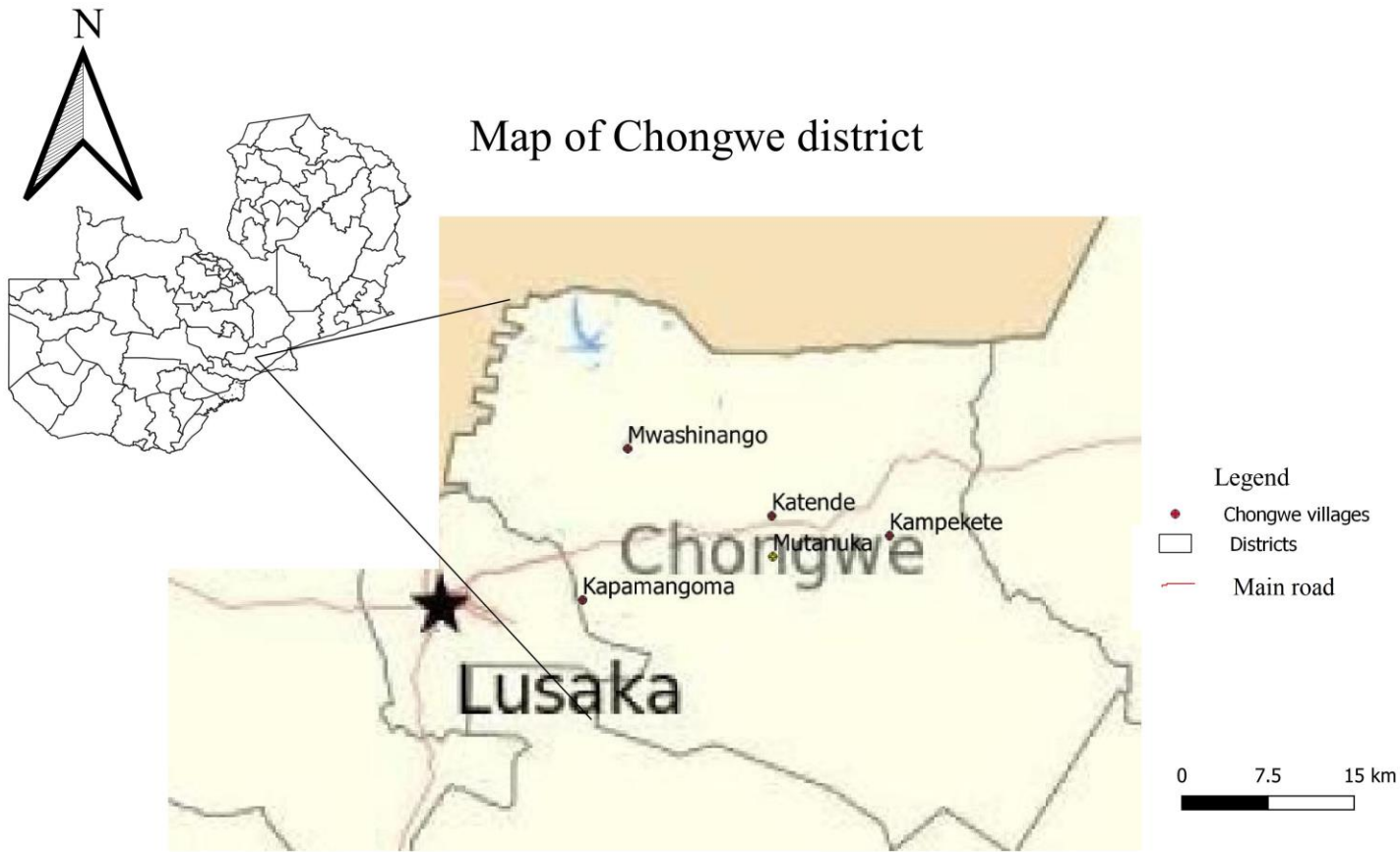


Figure 1: Map of Chongwe, Zambia.

Chongwe district lies between the relief of 300 and 1300 metres above the sea level. It is covered by three main types of vegetation; miombo (*Brachystegia*) woodland, mopane (*Colophospermum mopane*) woodland, and munga (*Acacia*) woodlands (Milupi *et al.*, 2020). The Soli people are the original inhabitants of Chongwe district under the chieftainship of Nkomeshya (Milupi *et al.*, 2020) . Chongwe district has a population of 192,303 of which 96,685 (50.3 %) are female and 95,618 (49.7 %) are male (Central Statistical Office, 2012).

### **3.2 Ethnobotanical study**

Ethical clearance was sought from the Natural Sciences ethics committee and permission to conduct this study in designated area was sought from headmen and chiefs of Chongwe. Informed consent forms were signed by each interviewee prior to the study as this was voluntary. Ethnobotanical data was collected using convenience and snowball sampling methods. Snowballing method is good for locating informants with adequate information about location and ethnobotanical data on the plants (Naderifar *et al.*, 2017).

Semi-structured questionnaires (Appendix 3) were administered to fifty informants who were knowledgeable of plant uses including traditional healers. The informants were from the villages of Chongwe where most people depend on plants for their living. The interviews were conducted in Nyanja, Bemba and English depending on the preference of the informants. The following data in relation to plants cultural value was recorded: local names, plant habitats and the uses of the plant.

Voucher specimens for the studied plants were collected and standard drying procedures were followed for about three days in a plant press. The plants specimens were identified and deposited in the University of Zambia herbarium. Plants were identified using prior knowledge, literature and comparisons with reference herbarium specimens.

### **3.3 Ethnobotanical study data analysis**

The ethnobotanical value of each species was assessed using the following three indices: Relative frequency of citation (RFC), cultural importance index (CI) and the relative number of uses (RNU<sub>s</sub>) which was used to calculate the cultural value index (CV) (Tardio and Pardo-de-

santayana 2008) using MS-excel. Cultural value was used in this study as it takes into account the multiplicity of uses of plants.

### 3.3.1 Relative frequency of citation

This was obtained by dividing the number of informants who mention a use for a plant by the total number of informants using the formula;

$$RFC_s = \frac{FC_s}{N} \quad (1)$$

Where:  $FC_s$  is the frequency of citations

$N$  is the total number of informants

### 3.3.2 Cultural importance index (CI)

The cultural importance index (CI), was obtained by the summation of the use reports using the formula;

$$CI_s = \sum_{u=u_1}^{u_{NC}} \sum_{i=i_1}^{i_N} UR_{ui}/N \quad (2)$$

Where:  $N$  is the total number of informants

$UR$  is the use reports by informants

### 3.3.3 Relative number of uses (RNU<sub>s(max)</sub>)

The maximum Relative Number of Use value in all the species was obtained using the formula:

$$\text{RNU}_{s(\max)} = \text{NU}_s / \text{NC} \quad (3)$$

Where: NU<sub>s</sub> is number of different uses

NC is number of use-categories

### 3.3.4 Cultural value index (CV)

The cultural value index was obtained using the formula:

$$\text{CV}_s = \left[ \text{NU}_s / \text{NC} \right] \times \left[ \text{FC}_s / \text{N} \right] \times \left[ \sum_{u=u_1}^{u_{\text{NC}}} \sum_{i=i_1}^{i_{\text{N}}} \text{UR}_{ui} / \text{N} \right] \quad (4)$$

## 3.4 Experimental data collection on plant functional traits

Seeds were collected from eight plants that were found to have the highest ethnobotanical values (Table 1) from among those that were fruiting in the natural forests of Chongwe. This was due to a limited number of fruiting plants within the data collection period of 5 months. Forty-five fresh fruits were collected from each species. After collection, seeds were planted within 48 hours. Fruits were transported to the University of Zambia at the department of biological sciences for plantation. Fruits were stored in the refrigerator (Figure 2) at a temperature of 2°C to 3.5°C for not more than 2 days prior to the onset of the experiment (Chama *et al.*, 2013) to prevent the physiological change of the fruit constituents.

Prior to the onset of the experiment, fifteen fruits of each species were weighed using an analytical balance and the mean weight was recorded. The other fifteen fruits of each species were depulped and washed. After having been washed, seed parameters such as length (the longest part of the seed), height (from base to top) and width (the least of three dimensions of the seed) were measured in millimetres (mm) using a Vernier calipers. Seed dimensions were determined by placing the seed on the flat surface and until it settles. It is from these dimension that the seed shape was measured. The remaining fifteen fruits were just depulped but not washed prior to planting.



**Figure 2:** Storage of fruits collected from eight plant species at 2°C to 3.5°C prior to planting.

### **3.4.1 Experimental design for germination studies**

#### **3.4.1.1 Fruit weight**

Out of the twenty highest-ranked ethnobotanically valued plant species, fruits from the eight species of highest ethnobotanical values were collected. For each of the collected fruits, the mean weight in grams (g) of 15 fruits per species was determined using an analytical balance.

### 3.4.1.2 Seed shape.

Seed shape was determined and recorded (Table 3) prior to experimental onset of the experiment using the Flatness Index (FI) which ranges from one for spheres to values greater than two for spindle seeds. FI is based on the relationship between the particle dimensions along the three principal axes such as length, width and height (Cervantes *et al.*, 2016).

The index is given by

$$FI = (L+W)/2H \quad (5)$$

Where:

$L$  is the length of the seeds,  $W$  is the width of the seeds and  $H$  the height of the seeds.

Figure 3 below shows how the parameters of seeds determined and measured using a Vernier calipers. The mean FI of the fifteen seeds of each species was determined and recorded in table 3.

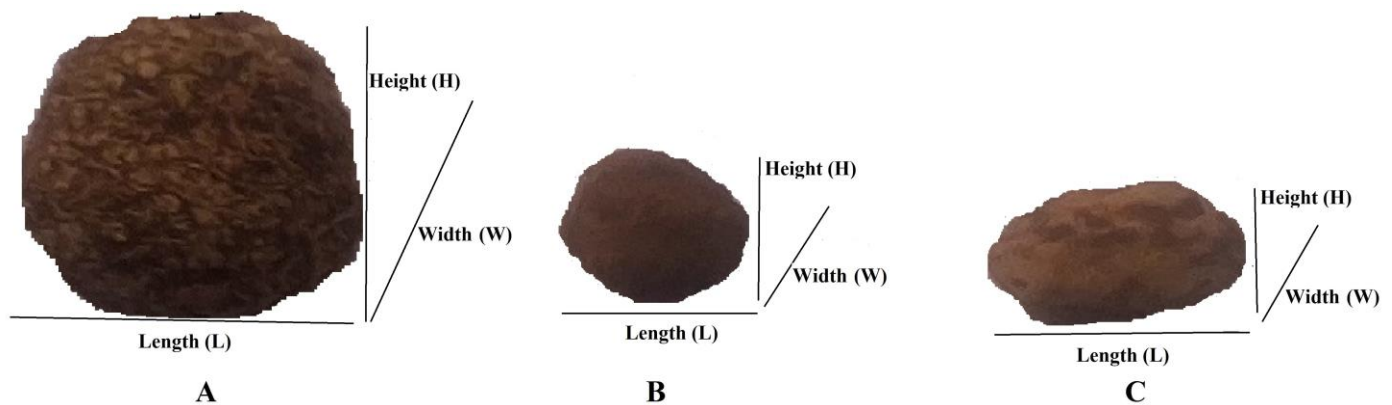


Figure 3: Seed of *P. maprouneifolia* (A), *O.kirkii* (B) and *F. indica* (C) showing seed shape measurements based on flatness index. Flatness Index (FI) is based upon the relationship between the particle dimensions along the three principal axes of length, width, and height of the seeds.

### 3.4.1.3 Treatment

Fruits of *Pseudolachnostylis maprouneifolia* (Pax) Rudd.Sm, *Flacourtia indica* (Burm F.) Merr, *Grewia stolzii* Ulbr, *Thespesia garckeana* F.Hoffm, *Ormocarpum Kirkii* S. Moore, *Ziziphus mauritiana* Lam, *Solanum villosum* Mill and *Bridelia cathartica* G. Bertol were collected and subjected to three treatments being pulped, depulped not washed, and depulped washed. The pulped seeds were sown as intact fruits which saved as a control. The depulped not washed seeds were hand cleaned but were not washed whilst the depulped washed seeds were hand cleaned and then washed with distilled water to remove all the pulp contents. Each treatment had 15 seeds hence forty-five seeds of each species were collected. Therefore, 15 seeds were planted intact (pulped), 15 were depulped but not washed and the other 15 were depulped and washed. All seeds were sown at a depth of 1.5 cm deep in each plastic bag of 4 cm<sup>3</sup>. Each bag was filled with natural surface soil from the area of study of about 25 to 41 cm deep which is a mineral horizon and fertilizer was not added. Soil type was loamy soil. A total of 360 seeds were planted in 4cm<sup>3</sup> plastic bags inside the plant shade at UNZA, Department of Biological Sciences, which allows natural light from the sun. The plants were watered on a daily basis at 08:00 hours and 16:00 hours. Seedling emergence for each seed and total germination were recorded. A stratified randomized design layout was used to place within the plant shed, the 4cm<sup>3</sup> plastic bags in which each seed was planted (Figure 4). Data was collected and recorded in an experimental record sheet (Table 3).



**Figure 4:** Part of an experimental layout showing germination status of some plants after 124 days of seed planting. Note: P = pulped seeds, DNW= depulped not washed seeds, DW = depulped washed seeds.

### 3.6 Experimental data analysis

Analysis was done to determine the variation in seed germination and seedling emergence among the germinated plant species with respect to fruit weight, seed shape and treatment. Pearson and Spearson's rho correlation analysis were used to test the effects of seed shape and fruit weight respectively on Seedling Emergence which is the day of first leaf shoot (Chama *et al.*, 2013), Germination Rate (the number of seeds germinating per given time) and Germination Percentage which is the number of total germinated seeds/Total number of seeds tested  $\times 100$  (Shahi *et al.*, 2015). Pearson and Spearsons' rho correlation are the best method of measuring the

association between variables of interest because they are based on the method of covariance and give information about the magnitude of the correlation, as well as the direction of the relationship. Boxplot and bar graphs were used to plot the graphs on the effect of fruit weight and seed shape on seedling emergence, germination rate and germination percent using SPSS and excel. Seedling Emergence, germination rate and Germination Percentage as response variables were tested against treatments (pulped, depulped not washed and depulped washed seeds) using a General Linear Model (GLM) adjusting for multiplicity, with treatment as fixed factor. The GLM multivariate procedure provides regression analysis and analysis of variance for multiple dependent variables by one or more factor variables or covariates. All experimental statistical analyses were done using SPSS.

## CHAPTER FOUR

### RESULTS

#### 4.1 Ethnobotany

Respondents introduced 89 different plant species that were valued and practically used in Chongwe district, Zambia. Information was obtained through semi-structured, in-depth interviews of fifty people (age range of 25–60 years, mean age 40 years). Eighty percent of the informants were female and twenty percent were male.

Table 1 below shows species accession number, botanical name, local name, family, number of use category (NUC), frequency of citation (FC) use report (UR), number of uses (NU), cultural importance (CI), relative frequency of citation (RFC), relative number of uses (RNU), and cultural value (CV). *P. maprouneifolia* was ranked number one in terms of cultural value. *P. maprouneifolia* is a small tree with leaves alternate, broadly ovate to round. It was reported for various uses such as medicine, energy, technology and craft, animal food and social purposes. The plant uses were divided into nine use categories namely; medicinal (MED), energy (EN), technology and craft (TECH/CRAFT), human food (HF), animal food (AF), others (OTH), social (SOC), toxic (TOX) and ornamental (ORN). Out of the 89 species reported by respondents to be used for various purposes, the 20 highest ranked species based on cultural value have been presented in table 1.

**Table 1:** The first 20 highest ranked species out of 89 named species from Chongwe based on the cultural value index. Cultural value index: CI=cultural importance, RFC=relative frequency of citation, CV=cultural value, FC= frequency of citation, UR=number of use: reports, NU=number of uses

Species Accession Number	Botanical Name	Local Name	Family	Basic values				Indices				Ranking			
				USE CATEGORY	FC	UR	NU	CI	RFC	RNU	CV	CI	RFC	RNU	CV
22307	<i>Pseudolachnostylis maprouneifolia</i> (Pax) Rudd.Sm	Musolo (Tonga)	Phyllanthaceae	6	33	93	6	1.86	0.66	0.666667	0.8184	1	2	6	1
22380	<i>Flacourtia indica</i> (Burm F.) Merr	mutumburwa (Senga)	Salicaceae	8	25	79	8	1.58	0.5	0.888889	0.702222	4	5	1	2
22305	<i>Grewia stolzii</i> Ulbr	Mulyapwele (Bemba)	Malvaceae	7	25	90	7	1.8	0.5	0.777778	0.7	3	5	1	3
22389	<i>Piliostigma thorningii</i> (Schumach.) Milne-Redh	musekese (Senga)	Fabaceae	7	24	91	7	1.82	0.48	0.777778	0.679467	2	7	1	4
22369	<i>Thespesia garckeana</i> F.Hoffm.	Makole (Bemba)	Malvaceae	7	30	39	7	0.78	0.6	0.777778	0.364	7	3	1	5
22293	<i>Ormocarpum Kirkii</i> S. Moore	Magwilinti (Tonga)	Fabaceae	4	28	48	4	0.96	0.56	0.444444	0.238933	6	4	9	6
22368	<i>Ziziphus mauritiana</i> Lam	Masawo (Senga)	Rhamnaceae	7	14	54	7	1.08	0.28	0.777778	0.2352	5	8	1	7
22343	<i>Solanum villosum</i> Mill	Mutuntulwa (Nyanja)	Solanaceae	5	36	20	5	0.4	0.72	0.555556	0.16	15	1	4	8
22294	<i>Bridelia cathartica</i> G. Bertol	Musalalu osagona (Nyanja)	Phyllanthaceae	6	13	21	6	0.42	0.26	0.666667	0.0728	14	9	1	9
22362	<i>Parinari curatellifolia</i> Planch. ex Benth.	Mupundu (Bemba)	Celastraceae	2	9	36	5	0.72	0.18	0.555556	0.072	8	15	3	10

22350	<i>Bauhinia petersiana</i> Bolle	Mupondo (Tonga)	Fabaceae	4	11	36	4	0.72	0.22	0.444444	0.0704	8	11	5	11
22310	<i>Vitex doniana</i> Sweet	Musibi, Mufutu (Tonga, Bemba)	Lamiaceae	6	8	26	6	0.52	0.16	0.666667	0.055467	12	19	1	12
22314	<i>Monanthes obovata</i> (Benth.) P.H.Hoekstra	Muchingachinga (Senga)	Annonaceae	6	10	28	4	0.56	0.2	0.444444	0.049778	11	12	4	13
22317	<i>Ficus wakefieldii</i> Hutch.	Mupulampako, Mtowa, Mtawa (Bemba, Tonga, Nyanja)	Moraceae	5	9	24	5	0.48	0.18	0.555556	0.048	13	15	2	14
22335	<i>Diplorhynchus condylocarpon</i> (Mull. Arg)	,Mwenge, Mutowa (Bemba, Tonga)	Apocynaceae	3	10	32	3	0.64	0.2	0.333333	0.042667	10	12	10	15
22387	<i>Faidherbia albida</i> (Delile) A. Chev	Mulyansofu (Tonga)	Fabaceae	4	12	20	4	0.4	0.24	0.444444	0.042667	15	10	3	15
22383	<i>Combretum collinum</i> Fresen.	Mufunta (Tonga)	Chrysobalanaceae	5	9	17	3	0.34	0.18	0.333333	0.0204	17	15	9	17
22370	<i>Syzygium guineense</i> (Willd.) DC.	musiniga, Nsafwa (Nyanja, Bemba)	Myrtaceae	6	5	14	6	0.28	0.1	0.666667	0.018667	20	26	1	18
22290	<i>Annona stenophylla</i> Engl & Diels. Subsp. Nana (exell) N.Robson.	Mulolo (Tonga)	Annonaceae	3	7	17	3	0.34	0.14	0.333333	0.015867	17	21	8	19
22304	<i>Mimusops zeyheri</i> Sond	Nchenja (Soli)	Sapotaceae	4	5	16	4	0.32	0.1	0.444444	0.014222	19	26	2	20 <sup>1</sup>

Cultural value index: CI=cultural importance, RFC=relative frequency of citation, CV=cultural value, FC= frequency of citation, UR=number of use: reports, NU=number of uses.

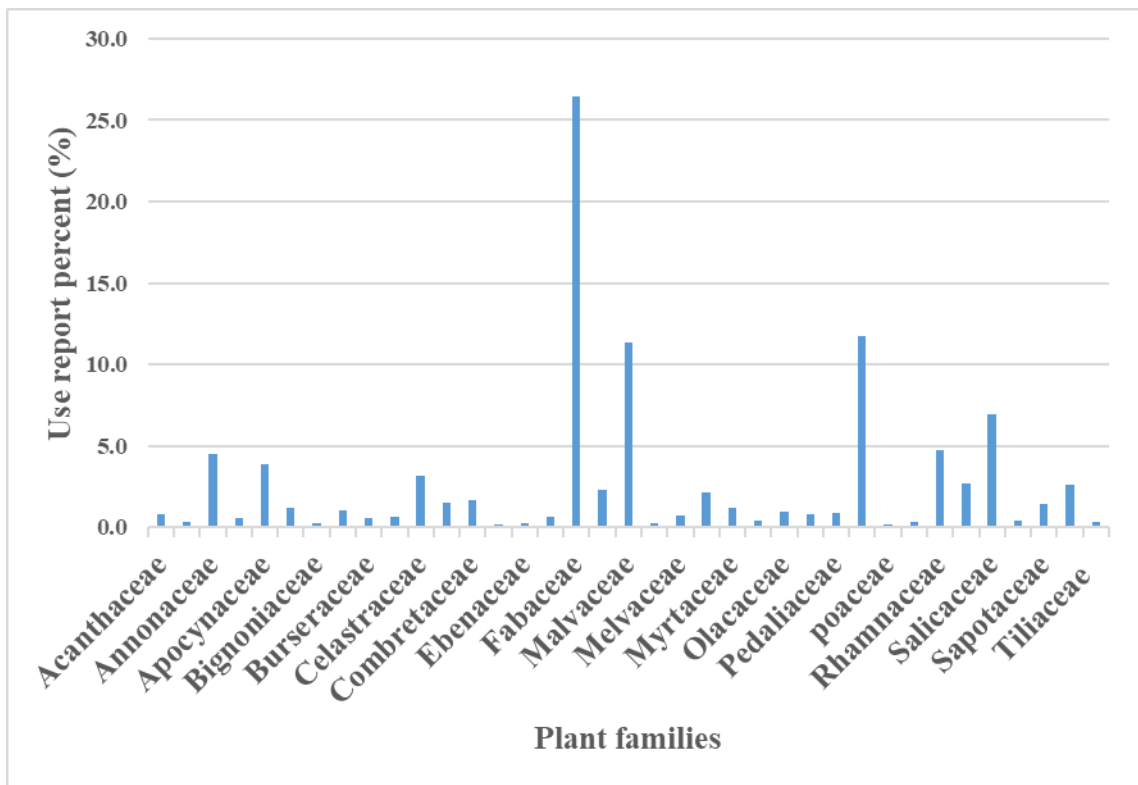
**Table 2: Number of use-reports (UR) and percentage of use categories**

	Categories (Codes)	UR	Percentage
1	Medicinal (MED)	383	33.6
2	Human Food (HF)	170	14.9
3	Animal Food (AF)	48	4.2
4	Energy (EN)	274	24.0
5	Toxic (TOX)	7	0.6
6	Technology and craft (TECH/CRAFT)	190	16.7
7	Social (SOC)	26	2.3
8	Ornamental (ORN)	5	0.4
9	Others (OTH)	37	3.2
	Total	1140	100.0

Out of 1140 UR from 50 informants in Chongwe, medicinal use was reported the highest (Table 2) followed by energy which includes both charcoal production and Firewood. Moreover, some plants such as *S. hispidum* and *G. amygdalinum* were reported to have only medicinal values and were used to treat various ailments (appendix 1). For example *S. hispidum* was used to treat ailments such as such as diarrhoea, stomach pain, whooping cough, bilharzia, deworming, diabetes, fever, malaria, dysentery and ulcers. *S. hispidum* is a small shrub of about three to five feet tall, noticeable for its large, velvety, fuzzy leaves. The trunk and branches can have small thorns, though they are not particularly prominent. The large leaves grow to several inches with cherry-tomato sized fruits follow and ripen to a dark purple with grayish green spots. The fruits are probably not edible. *G. amygdalinum* is a much-branched, evergreen shrub or small tree,

growing up to ten metres tall. It was reported to have been used for various medicinal purposes such as toothache, paronychia, abortion, stomach pain, malaria, fever, gonorrhoea, bola bola, syphilis and inducing labour. Ornamental plants was the least used category in Chongwe.

Figure 5 below, shows the percentage distribution of UR among the nineteen families introduced by fifty informants. Fabaceae had a significant UR compared to other families.



**Figure 5:** Percentage use report of plant families introduced by the respondents

## 4.2 Experimental results

Out of the twenty highest ranked species in terms of CV, eight species were planted to determine the effect of their functional traits on seed germination and seedling emergence. Only five species showed germination making up to 62.5% of germination. *B. cathartica*, *S. villosum*, *G. stolzii*, *T. garckeana* and *F. indica* germinated while *Z. mauritiana*, *P. maprouneifolia* and *O. kirkii* did not show any germination. Seedling emergence ranged from 4 days in the depulped washed seeds of *G. stolzii* to 139 days in the intact fruits of *B. cathartica*.

**Table 3:** Results showing seed shape, fruit weight, date of planting seeds, seedling emergence, germination rate, germination percentage and total germination performance of the planted species. Note: out of eight selected species for experimentation only five species germinated

Date of planting seeds 14/09/2020															
Botanical Name	Fruit Weight (g)	Seed Shape (Fl)	Seedling Emergence (days)			Germination Rate (germination /day)			Germination Percentage (%)			Total germination performance			
			Pulped	Depulped Not Washed	Depulped washed	Pulped	Depulped Not Washed	Depulped washed	Pulped	Depulped Not washed	Depulped washed	Total germination	Seedling Emergence (days)	Germination Rate (germination /day)	Germination Percentage
<i>Flacourtia indica</i> (Burm F.) Merr	5.61	1.33	0	88	71	0	2.5	0.33	0	33.3	53.3	13	71	0.54	28.9
<i>Grewia stolzii</i> Ulbr	0.92	1.59	9	7	4	2	2	2.3	13.3	13.3	46.7	11	4	3.7	24.4
<i>Solanum villosum</i> Mill.	5.1	1.13	124	122	119	0.3	0.33	0.53	20	26.7	53.3	14	119	0.93	31.1
<i>Thespesia garckeana</i> F. Hoffm.	11.5	1.4	134	60	9	1	1	0.1	6.7	6.7	33.3	7	9	0.06	15.6
<i>Bridelia cathartica</i> G. Bertol	1.03	1.06	139	139	134	1	1	0.8	6.7	6.7	26.7	6	134	1.2	13.3
<i>Pseudolachnostylis maprouneifolia</i> (Pax) Rudd.Sm	5.81	1.2													
<i>Ormocarpum Kirkii</i> S. Moore	5.81	1.2													
<i>Ziziphus mauritiana</i> Lam	5.21	1.25													

#### 4.2.1 Effects of seed depulping and washing on seedling emergence

Figure 6 below shows the response of individual species with respect to treatment (Pulped, depulped not washed and depulped washed). Of all the species that germinated, *B. cathartica* took longer to germinate in all treatments (Table 3), but longest in pulped seeds which took 139 days to germinate and a little lesser in the depulped washed seeds, although the mean difference was not significant ( $P > 0.05$ , Table 4). The seedling emergence pattern of *S. villosum* is similar to that of *G. stolzii*. However, *S. villosum* took 119 days for seedlings to emerge compared to *G. stolzii* which only took 4 days for seedlings to emerge (Table 3). *T. garckeana*, showed a significant difference in terms of seedling emergence across the treatments with less time in depulped washed seed and longer in pulped seeds. *F. indica* showed a difference in seedling emergence across the treatment despite it not being significant. The depulped washed seeds had a lower seedling emergence than the depulped not washed seeds and there was no germination in intact fruits (Figure 6; Table 3).

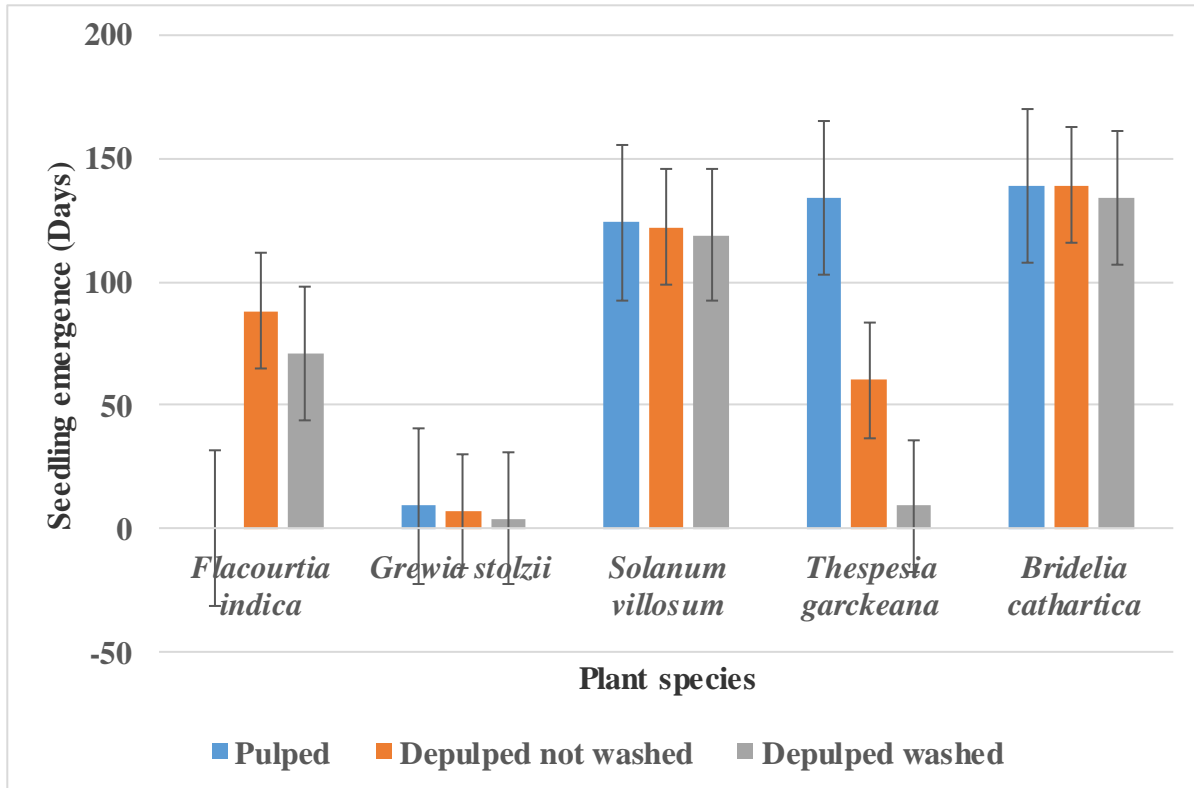
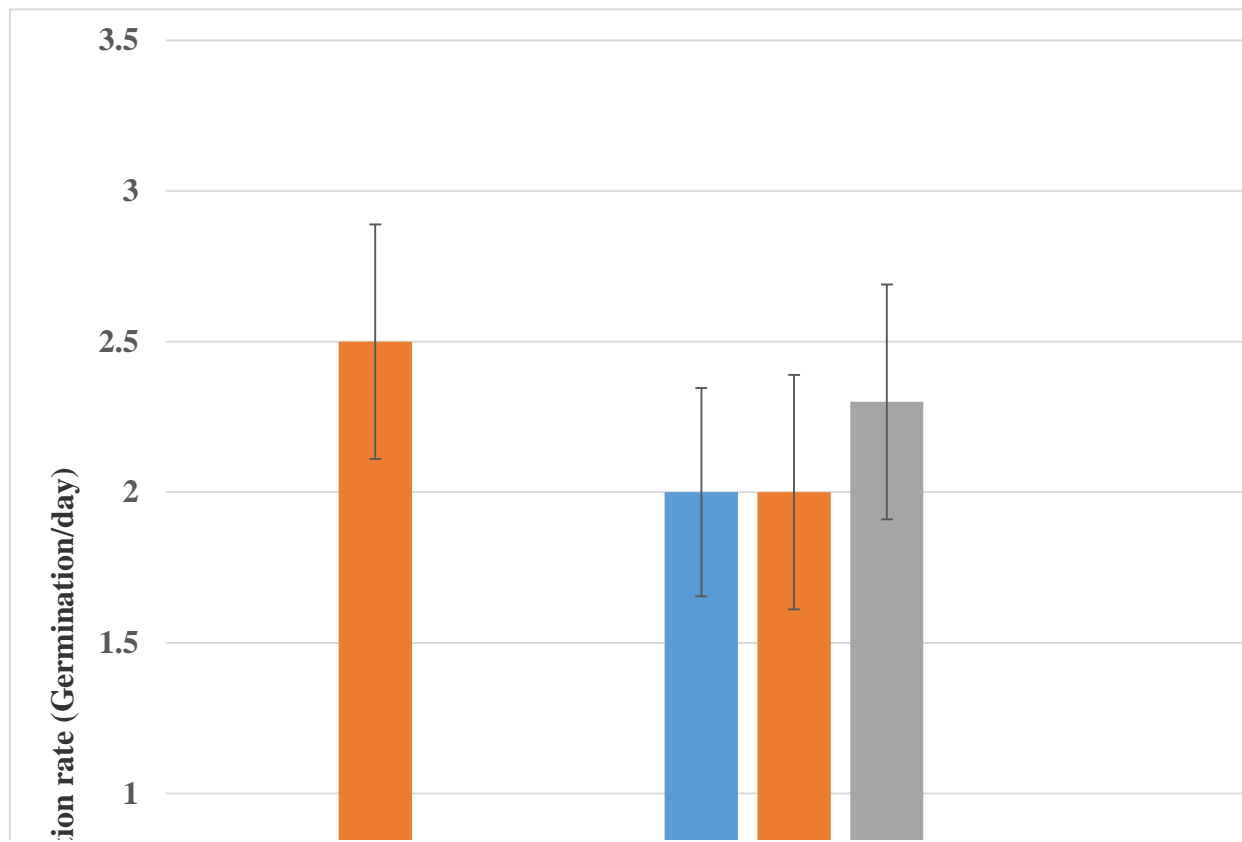


Figure 6: Effect of treatment on individual species seedling emergence

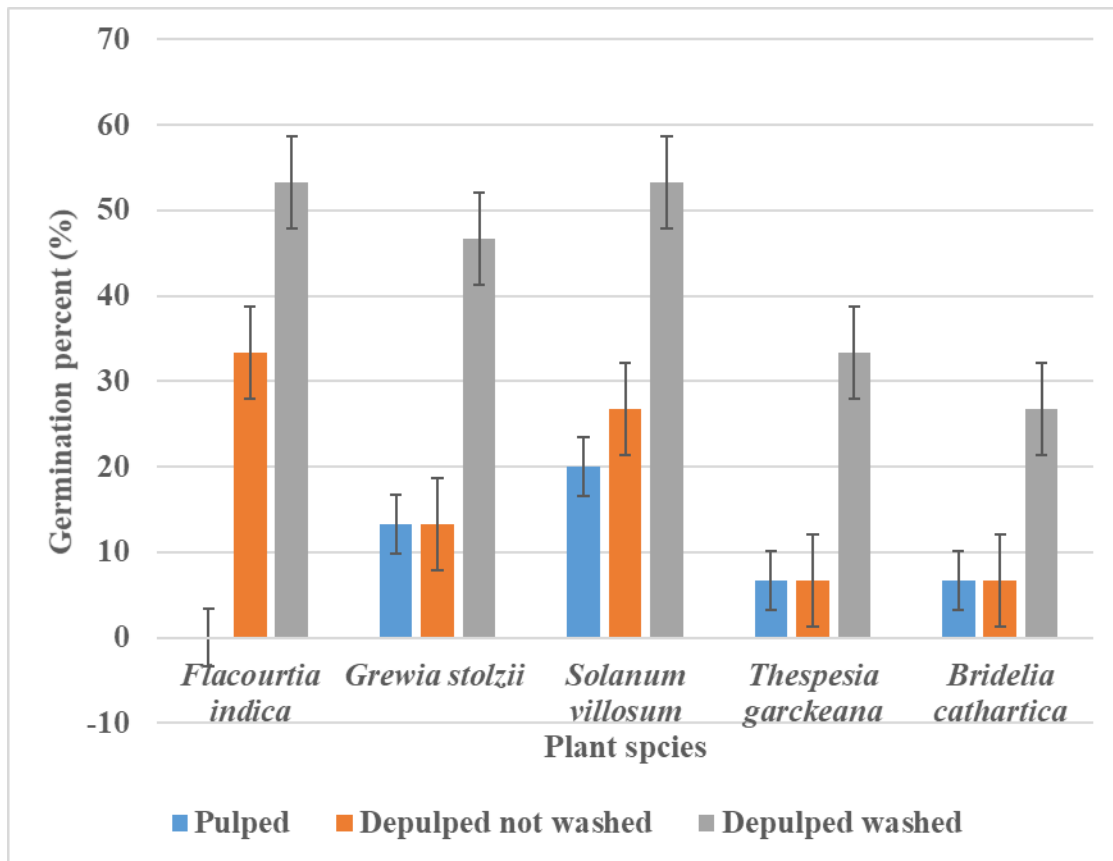
Figure 7 below shows the germination rate response of individual species with respect to treatment. Of all the species that germinated, depulped not washed *F. indica* seeds recorded the highest germination rate of 2.5 germinations/day with zero germination rate in the pulped seed as there was no germination. Generally, *G. stolzii* had the highest germination rate across the treatments, with no difference between pulped and depulped not washed seeds. However, a marginal difference existed when compared to depulped washed seed germination rate which was not significant. *S. villosum* recorded the lowest germination rate with less germination rate in intact fruits of 0.3 germinations/day followed by depulped not washed seeds whose germination rate was 0.33 germination/day and then the highest germination rate of 0.53 germination/day was recorded in the depulped washed seeds. *T. garckeana* recorded no significance difference in

terms of germination rate response between the pulped and depulped not washed seeds but showed a significantly lower germination rate in depulped washed seeds. Similarly, *B. cathartica* recorded no germination rate difference between the pulped and the depulped not washed seed however, there was a marginal difference on the depulped washed seeds which was the lowest among the treatments within the species.



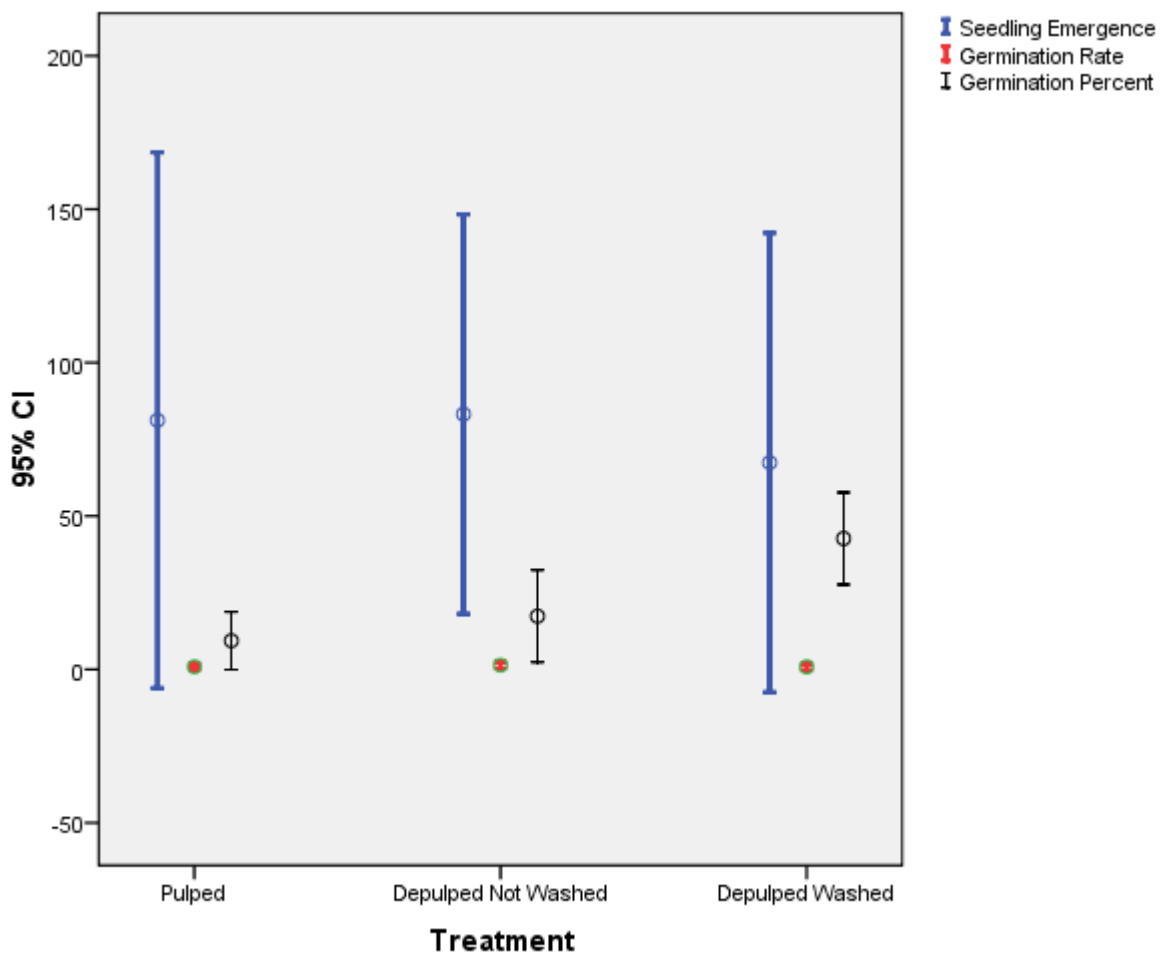
**Figure 7:** Effect of treatment on individual species germination rate.

In figure 8 below, *T. garckeana*, *B. cathartica*, *G. stolzii* and *S. villosum* portrayed a similar pattern of germination percent response across treatments in which there was no significant difference between pulped and depulped not washed seeds despite a marginal difference in *S. villosum*. However, there was a significant increase in germination percent of the depulped washed seeds. *F. indica* showed a response in which the pulped seeds did not germinate, whilst a significant difference existed between the depulped not washed seeds and the depulped washed seeds.



**Figure 8:** Effect of treatment (seed depulping and washing) on individual species germination percent

Figure 9 below shows the general effects of treatment on seedling germination, germination rate and germination percentage of seeds irrespective of individual species considering eight replicates. It shows that there was no significant effect of treatment on seedling emergence and germination rate. However, there was a significant effect in terms of germination percent and this effect was highly pronounced on the depulped washed seeds than between the pulped and depulped not washed seeds



**Figure 9:** General effect of treatments (seed depulping and washing) on seedling emergence, germination rate and germination percent.

Table 5 shows the pairwise comparison of GLM analysis on the effect of treatments on germination performance of seeds irrespective of individual species. It shows that seedling emergence and germination rate were not generally significantly affected by treatment ( $P > 0.05$ ). However, treatment generally significantly affects the germination percentage of seeds regardless of the kind species.

Table 4: Results of pairwise comparisons on the general effect of treatment on seedling emergence, germination rate and germination percent showing parameters, mean difference, standard errors (Std. Error), P-values, and the lower and upper bounds of the 95% confidence interval for difference. Note: Significant p-values are highlighted in bold.

**Pairwise Comparisons**

Dependent Variable	(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig. <sup>a</sup>	95% Confidence Interval for Difference <sup>a</sup>	
						Lower Bound	Upper Bound
Seedling Emergence	Depulped Not Washed	Depulped Washed	15.800	38.856	.691	-68.861	100.461
		Pulped	2.000	38.856	.960	-82.661	86.661
	Depulped Washed	Depulped Not Washed	-15.800	38.856	.691	-100.461	68.861
		Pulped	-13.800	38.856	.729	-98.461	70.861
Pulped	Depulped Not Washed	-2.000	38.856	.960	-86.661	82.661	
	Depulped Washed	13.800	38.856	.729	-70.861	98.461	
Germination Rate	Depulped Not Washed	Depulped Washed	.554	.531	.317	-.603	1.711
		Pulped	.506	.531	.359	-.651	1.663
	Depulped Washed	Depulped Not Washed	-.554	.531	.317	-1.711	.603
		Pulped	-.048	.531	.929	-1.205	1.109
Pulped	Depulped Not Washed	-.506	.531	.359	-1.663	.651	
	Depulped Washed	.048	.531	.929	-1.109	1.205	
Germination Percent	Depulped Not Washed	Depulped Washed	-25.320*	6.833	<b>.003</b>	-40.208	-10.432
		Pulped	8.000	6.833	.264	-6.888	22.888
	Depulped Washed	Depulped Not Washed	25.320*	6.833	<b>.003</b>	10.432	40.208
		Pulped	33.320*	6.833	<b>.000</b>	18.432	48.208
Pulped	Depulped Not Washed	-8.000	6.833	.264	-22.888	6.888	
	Depulped Washed	-33.320*	6.833	<b>.000</b>	-48.208	-18.432	

Based on estimated marginal means

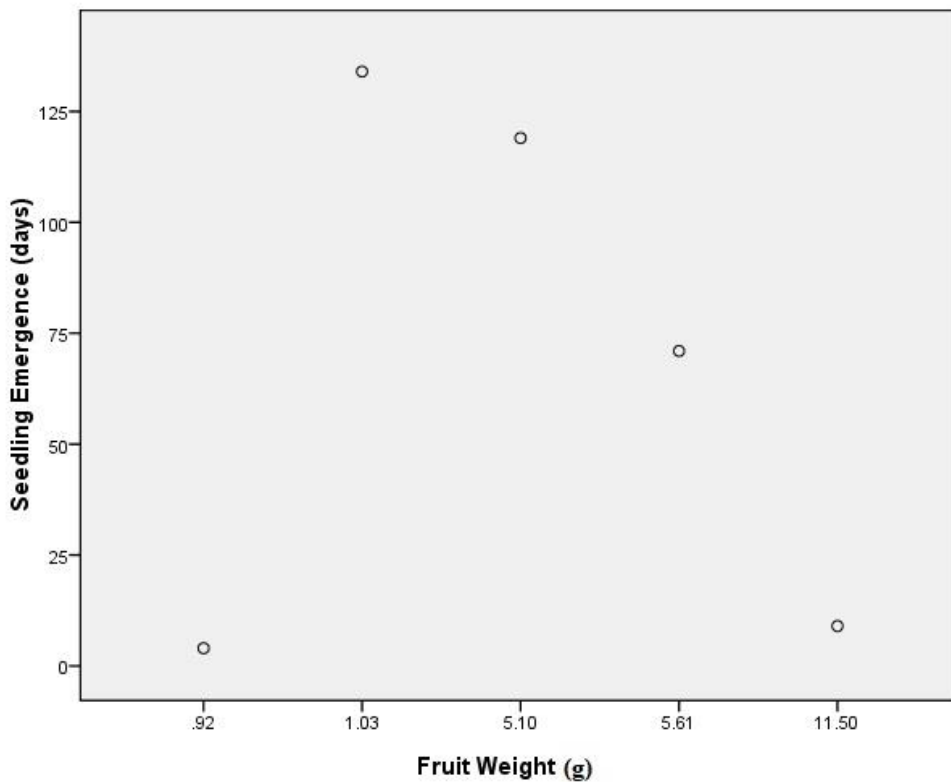
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

\*. The mean difference is significant at the .05 level.

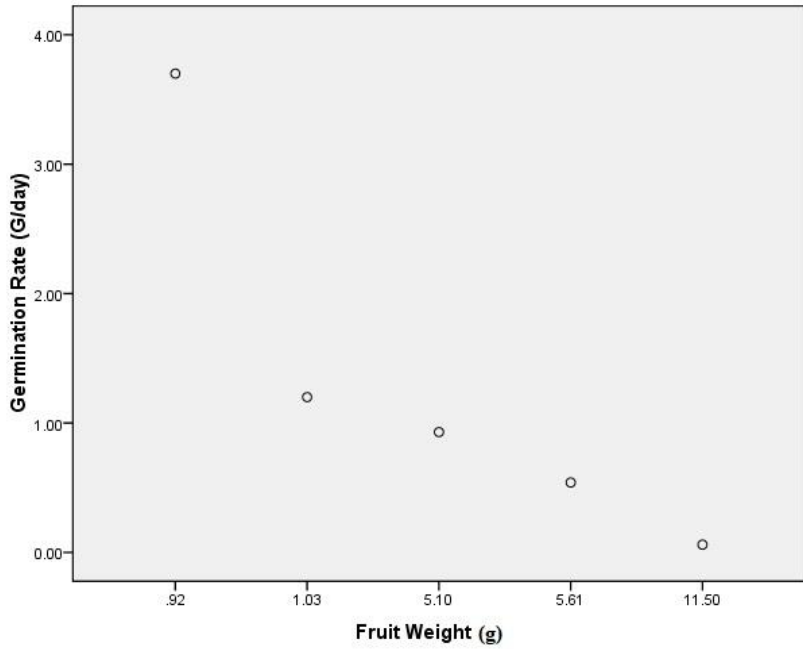
Germination percentage was significantly high in depulped washed seeds (Table 4;  $p < 0.05$ ). However, there was no significant difference between the pulped and depulped not washed seeds (Figure 9; Table 4;  $P > 0.05$ )

### 2.1.1 Effect of fruit weight on seed germination and seedling emergence

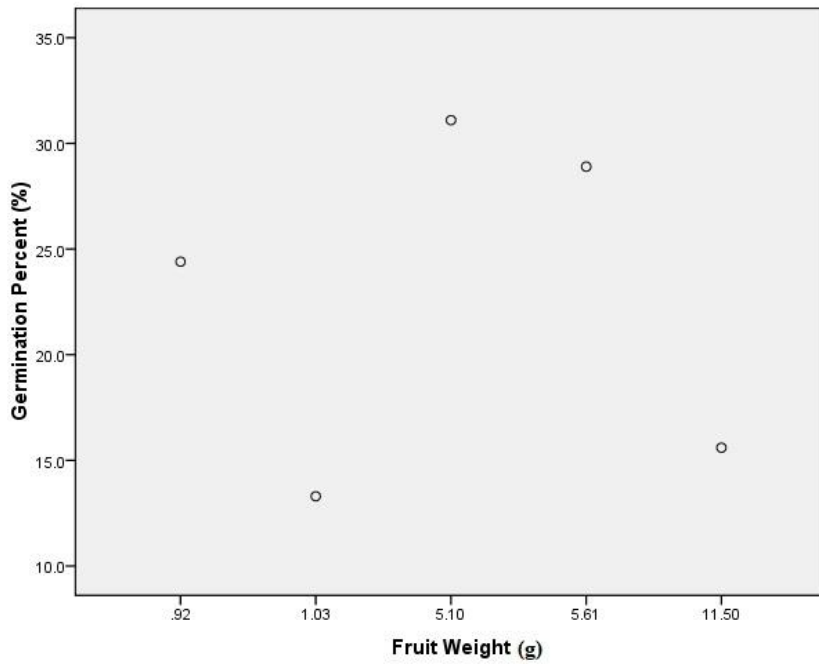
Figure 10 below shows the response of seedling emergence, germination rate and germination percent to fruit weight. Figure 10 (a) and (b) do not show a clear correlation whilst (b) shows that there was an increase in germination rate with decrease in fruit weight.



a)



b)



c)

**Figure 10:** Effects of fruit weight in relation to (a) Seedling Germination (b) Germination Rate (c) Germination Percentage.

**Table 5:** Result of Spearson's rho analysis showing correlation coefficient and significance of fruit weight to seedling emergence, germination rate and germination percentage among the germinated plant species.

			Fruit Weight (g)	Seedling Emergence	Germination Rate	Germination Percentage
Spearman's rho	Fruit Weight (g)	Correlation Coefficient	1.000	.000	-1.000**	.100
		Sig. (2-tailed)	.	1.000	.	.873
		N	5	5	5	5
	Seedling Emergence	Correlation Coefficient	.000	1.000	.000	-.100
		Sig. (2-tailed)	1.000	.	1.000	.873
		N	5	5	5	5
	Germination Rate	Correlation Coefficient	-1.000**	.000	1.000	-.100
		Sig. (2-tailed)	.	1.000	.	.873
		N	5	5	5	5
Germination Percentage	Correlation Coefficient	.100	-.100	-.100	1.000	
	Sig. (2-tailed)	.873	.873	.873	.	
	N	5	5	5	5	

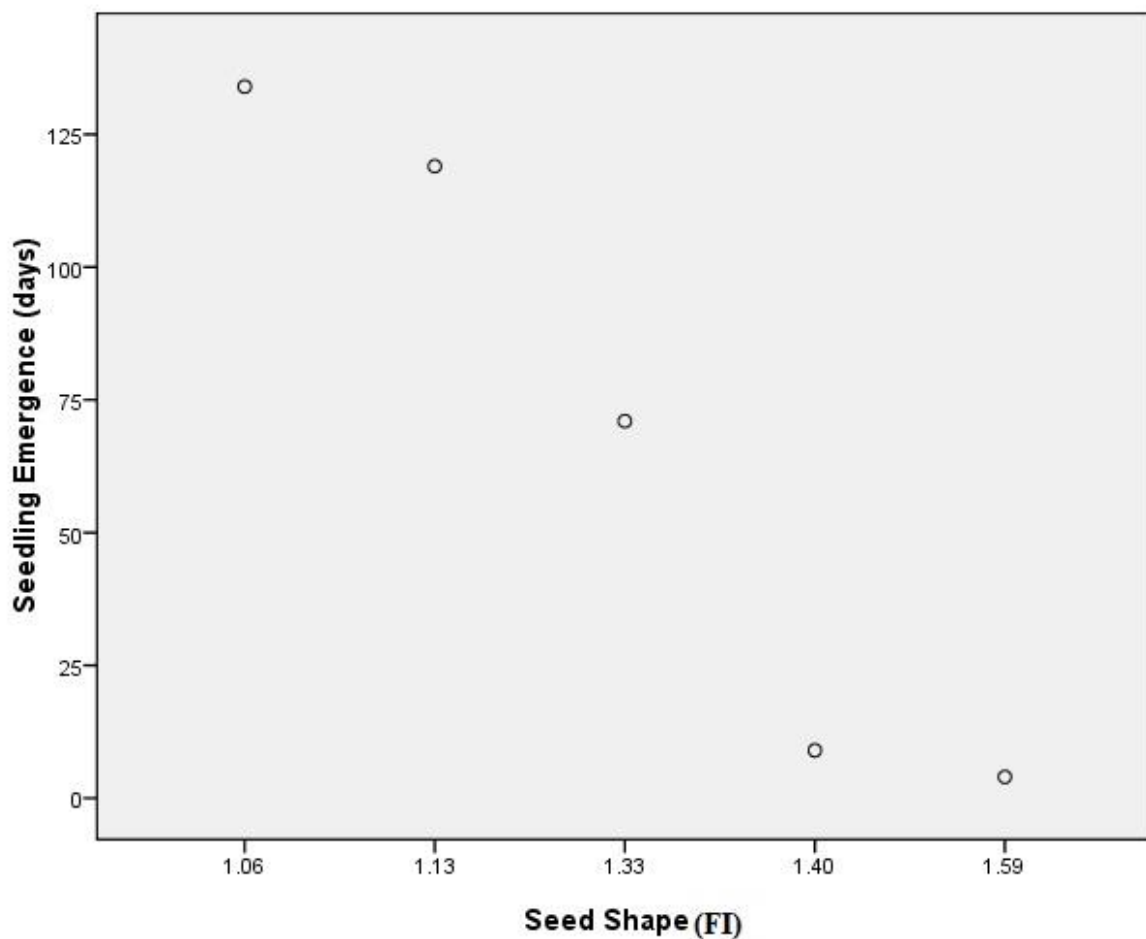
\*\*.

Correlation is significant at the 0.01 level (2-tailed).

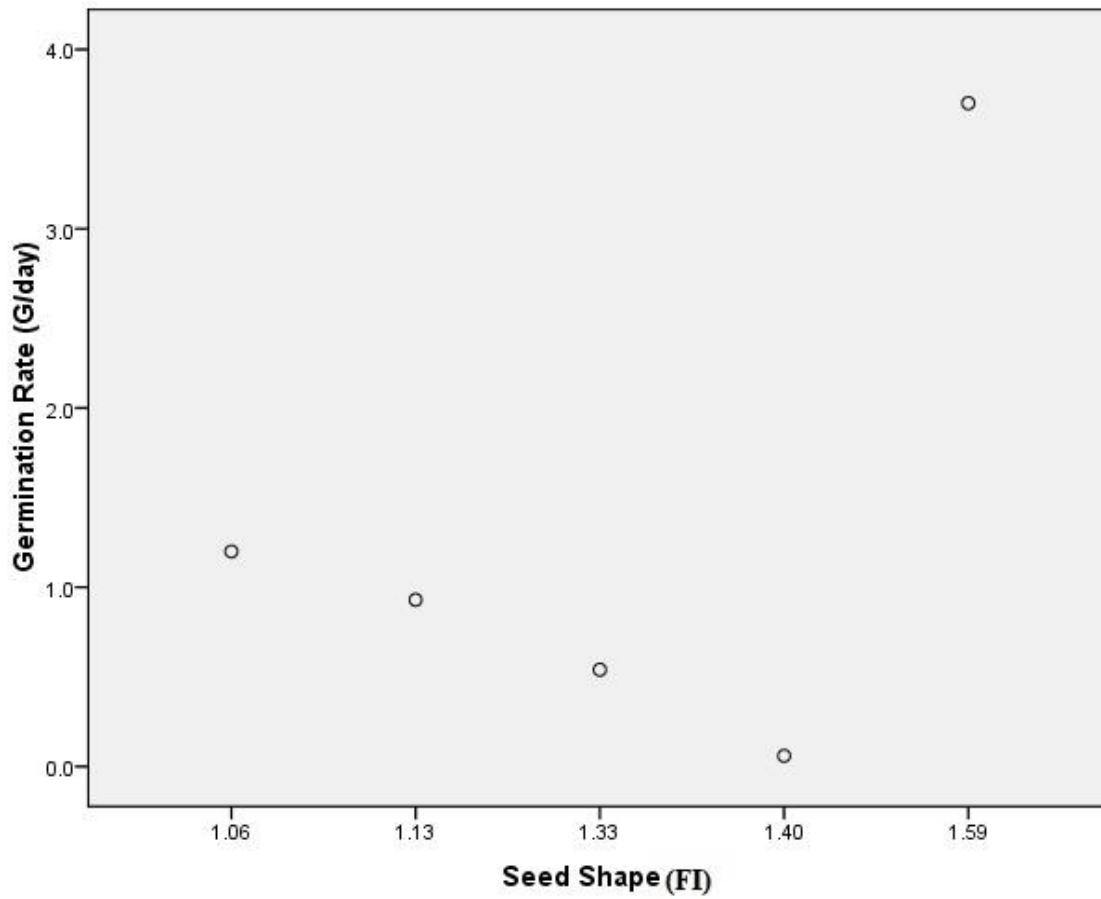
Table 5 above shows a negative correlation coefficient (-1.000) of germination rate and fruit weight which is significant ( $P < 0.01$ ). Germination rate increased with reduction in fruit weight.

### 4.2.3 Effect of seed shape on germination and seedling emergence

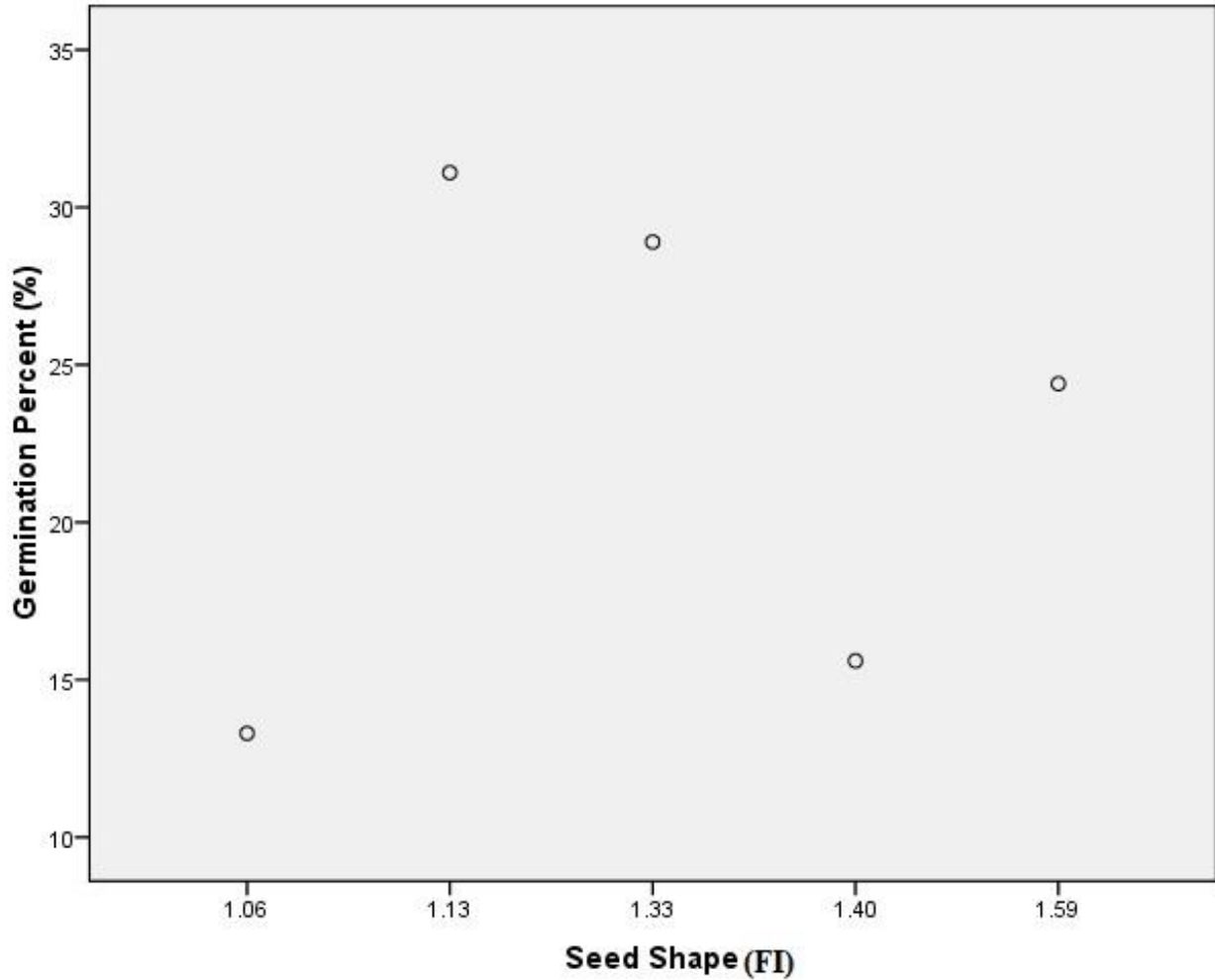
Figure 11 below shows a strong effect of seed shape on seedling emergence. Spherical seeds (seeds with FI close to one) showed a low seedling emergence compared to spindle seeds (seeds with FI greater than one to nearly two). The more spindle the seeds were, the less time it took for the seeds to emerge from the soil. No significant correlation between seed shape and germination rate or germination percent was observed.



a)



b)



c)

Figure 11: Effect of Seed Shape on (a) Seedling Emergence (b) Germination Rate and (c) Germination Percentage. Note: Seed shape (FI) is the sum of length and width divided by height multiplied by 2, which ranges from one for spherical seed to two for spindle shaped seeds.

**Table 6:** Results showing Pearson correlation and significance of correlation of seed shape to seedling emergence, germination rate and germination percentage among the germinated plant species. Significant p-values are highlighted in bold.

		Seed Shape	Seedling Emergence	Germination Rate	Germination Percent
Seed Shape	Pearson Correlation	1	-.951*	.527	.118
	Sig. (2-tailed)		<b>.013</b>	.361	.850
Seedling Emergence	Pearson Correlation	-.951*	1	-.317	.072
	Sig. (2-tailed)	<b>.013</b>		.603	.909
Germination Rate	Pearson Correlation	.527	-.317	1	.134
	Sig. (2-tailed)	.361	.603		.830
Germination Percent	Pearson Correlation	.118	.072	.134	1
	Sig. (2-tailed)	.850	.909	.830	

\*. Correlation is significant at the 0.05 level (2-tailed).

a. Listwise N=5

Table 6 above shows that seed shape had a significant effect on seedling emergence ( $P < 0.05$ ) as seedling emergence reduced from spherical (*G. stolzii*) to spindle shaped seeds (*B. carthatica*). However, it did not significantly affect the germination rate and percent.

## **CHAPTER FIVE**

### **5.0 DISCUSSION**

#### **5.1 Ethnobotany**

From the fifty informants in this study, ethnobotanical usage of eight-nine plant taxa were identified belonging to 19 families. These plant families were; Acanthaceae, Annonaceae, Apocynaceae, Bignoniaceae, Burseraceae, Celastraceae, Combretaceae, Ebenaceae, Fabaceae, Malvaceae, Melvaceae, Myrtaceae, Olacaceae, Pedaliaceae, Poaceae, Rhamnaceae, Salicaceae, Sapotaceae and Tiliaceae. For all eighty-nine native wild taxa recorded, botanical name, local name(s), taxonomic family, accession numbers and uses were documented (appendix 1). Among plant families, Fabaceae had the highest number of taxa. This should be of great concern as the difference in the use report of such plants to other families was highly significant (Figure 5). Therefore, species in Fabaceae family should be considered as priority species in botanical conservation as other studies have also shown species belonging to this family being the most used (Muyenga *et al.*, 2018; Chinsebu *et al.*, 2018; Adeniyi *et al.*, 2018). The reported use categories of plants in Chongwe were; medicinal (MED) which include plants that are used for medicinal purposes, human food (HF), animal food (AF), energy (EN) that consisted of plants that are used for charcoal and firewood production, toxic (TOX) consisted of plants that are used to poison animals, technology and craft (TECH/CRAFT) consisted of plants that are harvested for timber, recreation and craft purposes, social (SOC) included the plants that are used for social spiritual aspect to either be liked, loved or hated by other individuals, ornamental (ORN) included the plants that were planted or used to beautify the residential premises and others (OTH) which could not be categorized or that did not fall in the aforementioned categories

(Table 2). The use of plant species among the local people of Chongwe was quite diverse. Moreover, the diversity of uses of plants across different use categories, frequency of citation and cultural importance is an indication of the cultural value of the plant species (Table 1). The highest culturally valued plants are susceptible to over-harvesting in the process of meeting the local demands. The ten most used plant species of Chongwe were; *P. maprouneifolia*, *F. indica*, *G. stolzii*, *P. thorningii*, *T. garckeana*, *O. kirkii*, *Z. mauritiana*, *S. villosum*, *B. cathartica* and *P. curatellifolia*. In Chongwe, local people have extreme knowledge about local plants and uses, on which they are so intimately dependent for their survival.

In this area, plants traditionally play a major role in the treatment and management of human diseases and ailments despite no records of remedies have been used over time. Traditional medicinal plant practice in Chongwe district has been in existence just like any other regions in Southern Africa since the first settlement (Shumba *et al.*, 2009) and it was the highest in terms of UR. Out of nine use categories of plants in Chongwe, 33.6 percent UR of plants had medicinal values (Table 2). This indicates that most ethnobotanically valued plants of Chongwe have medicinal properties which if commercialized, they can contribute to economic growth of the local people. Despite most people in different areas and regions relying mostly on traditional medicines, the practice and medicinal values are not the same across the regions (Adeniyi *et al.*, 2018). The high number in medicinal uses could be due to limited access to modern medicines, lack of laboratory facilities, drug shortages and poor health worker attitudes that have raised the demand for traditional medicine as suggested by other studies (Coopoosamy and Naidoo, 2012; Chinsembu *et al.*, 2018; Shumba *et al.*, 2009). Similar to Chongwe district, medicinal plant taxa are the almost exclusively over-harvested to meet the demands of informal trade and consumer industry and to meet the demand of the growing population in Southern Africa (Nigro *et al.*,

2004). The top ranked four use categories in Chogwe were medicinal, human food, energy, and technology and craft making up to 89.2 % of plants UR (Table 2), hence if not critically considered under conservation strategies, plants of such use values are prone to extinction as they are being lost at an alarming rate. It is reported that about 280 000 ha of forests/woodlands are being lost at an alarming rate each year in Zambia (Shumba *et al.*, 2009) in which the top four use categories may be part of the drivers. Despite other plant species having lower cultural value index and use report, it does not mean that their practical uses are insignificant. This is because practical use of plants are not homogenous across ethnic groups. However, those of high CV are susceptible to over-harvesting. Therefore, such plants need attention for continuous existence. It was further observed that Chongwe residents do not cut most of the trees on their residential plots, but this was so because such plants had other uses attached to them and not for ornamental purposes and only few wild plants were planted or conserved as ornamental plants (Table 2, Appendix 1). This study highlighted culturally valued plant species which were then experimented on to understand the effects of some plant functional traits on seed germination and seedling emergence to optimize their regeneration.

## **5.2 Effect of functional traits on germination performance**

Some seeds that were planted did not show any germination, as seeds of different species may require different treatment in order to germinate. For example, *Z. mauritiana* may require the removal of the endocarp or naturally weathering (old) fruits to improve the germination performance (Grice, 1996) which could be the case for *O. kirkii* as well. On other hand *P. maprouneifolia* seeds did not show any germination as a result of their hard seed coat, which affects the capacity of hydration and brings about difficulties in seedling emergence. Therefore for germination to occur, the hard coat has to be scraped out or passed through fire (Usiri, 2010).

## **5.2.1 Effects of seed depulping and washing on seed germination and seedling emergence.**

### **5.2.1.1 Seedling emergence**

The response of seedling emergence to depulping and washing of seeds varied among species. This is likely due to the difference in fruit pulp constituents among species as some fruit pulp may have an inhibitory effect on germination (Amodeo *et al.*, 2017). In *B. cathartica*, *S. villosum* and *G. stolzii*, there was no significant difference across treatments. This is consistent with Chama *et al.*, (2013) who recorded no significant difference between the pulped and depulped seeds. However, *T. garckeana* showed a significant difference in terms of seedling emergence across the treatments with less time in depulped washed seed and longer in pulped seeds (Figure 6). This means that fruit pulp of *T. garckeana* may contain potential inhibition effects affecting seedling emergence. *F. indica* may have various complex mechanisms of dormancy that modulate their seedling emergence, involving physiological, morphological and physical factors as pulped seed had less seedling emergence time and the longest being depulped not washed seeds.

### **5.2.1.2 Germination rate**

According to the results of this study, germination rate responds differently among species because of variation in fruit pulp constituents, as species may contain potential inhibitors which may determine the germination rate depending on their levels (Price *et al.*, 2003). This concept by Price *et al.*, (2003) explains the effect of depulping and washing of seeds on germination rate in this study, where there was no significant difference in germination rate among the treatments in *G. stolzii*, *S. villosum* and *B. cathartica* whilst it existed in *F. indica* and *T. garckeana*

differently (Figure 7). The difference in response of germination rate to seed depulping and washing between *F. indica* and *T. garckeana* may be due to different pulp constituents having the different effects on germination rate (Robertson *et al.*, 2006). Moreover, in *F. indica*, other complex mechanisms seem to modulate their germination rate which is likely to be more of physical pulp coat and less of physiological factors as the removal of the pulp without washing had an increased in germination rate.

### **5.2.1.3 Germination percentage**

Germination percentage among all germinated species strongly favoured the depulped washed seeds. However, the germination percentage pattern among species may vary as the depulped not washed seeds may still contain traces of pulp constituents. This can cause variable results depending on the nature of the pulp constituents as well as the level of potential germination inhibitors. This is seen in *T. garckeana*, *B. cathartica*, *S. villosum* and *G. stolzii* in which there was no significant difference between intact fruits and the depulped not washed seeds in germination percentage (Figure 8). The GLM analysis using a pairwise comparison for the general response of germination percentage to treatment similarly showed a significant difference among treatments (Figure 9, Table 4;  $P < 0.05$ ) as germination percentage was significantly higher in depulped washed seeds than the pulped only and depulped not washed seeds. This was consistent with Robertson *et al.* (2006) and Amodeo *et al.* (2017), who suggested that fruit pulp may contain some constituents that may inhibit seed germination. This study shows that attention should be given to indigenous plant propagation to improve their germination percentage and this should be one of the methods of plant multiplication and ecological restoration especially among the plants of high ethnobotanical value that are susceptible to over-exploitation. Despite the local people's interest to participating in effective

biodiversity conservation, it is expensive to improved varieties of wild plants and local people cannot afford to fully meet the requirements hence this method is cheap for local people participation in the conservation of wild plants.

### **5.2.2 Effect of fruit weight on seed germination and seedling emergence**

Fruit weight had a significant effect on germination rate (Figure 10b) as germination rate increased with decrease in fruit weight. This is likely because fruit weight is positively correlated to pulp weight (Mkonda *et al.*, 2003) hence if the pulp has constituents that do not favour germination rate, the smaller fruits tend to have a higher germination rate than larger fruits. Therefore, fruit pulp being a parameter of commercial interest, the potential germination rate of the species in this study can be improved from the wild. This can be done by regulating the proportion of pulp through genetic selection (Mkonda *et al.*, 2003). However, the results of this study was opposite to Zimmerman and Weis, (1983) who found the positive correlation between fruit weight and germination rate as the increase in fruit weight resulted in an increase in germination rate that appeared to level off for the largest fruits. This could be due to the experiment being conducted on the same plant species which tend to have the same pulp constituents that could have exogenous constituents favouring germination rate. Therefore, the increase in fruit weight increases germination rate. Chama *et al.*, (2013) on a contrary did not find a significant effect of fruit weight on germination rate, which shows that the effect of fruit weight on germination rate should be species related depending on the pulp constituents and their physiological role in germination performance.

### 5.2.3 Effect of seed shape on seed germination and seedling emergence

The results of this study are consistent with Tabakovic *et al.*, (2020) who observed significant differences in seedling emergence between flat (spindle shaped) and round maize seeds. However, they combined the size and shape of the seeds and concluded that small and flat seeds emerged faster than the round ones. The results of this research as well indicates that seed shape had a significant effect on Seedling emergence (Figure 11a, Table 6,  $P < 0.05$ ) as Seedling emergence time reduced from spherical to spindle shaped seeds. The most spherical being *B. cathartica* which took 134 days and the most spindle being *G. stoltzii* which took four days for seedling emergence (Table 3). This is also consistent with Bu *et al.*, (2016) who found that elongated seeds germination faster than compact (round) seeds. This may be due to seed shape being related to surface area that provides contact with the external environment, as spindle shaped or flat seeds have a larger surface area than the spherical seeds hence higher exposure to environmental germination inducers like water and oxygen (Grundy *et al.*, 2003). Moreover, water uptake into seeds is a fundamental prerequisite of germination and commonly influence seed physiological processes such as water imbibition. Therefore, to reduce the seedling emergence time in wild species, genetic cloning can be done by improving the traits of spindle seed shape in a similar way to what was done to rice seeds by Ja-Hong *et al.*, (2021) for quick restoration of most used plants to mitigate the impact of over-harvesting. In rice, more than 400 quantitative trait loci associated with rice grain shape traits have been identified, and nearly 30 genes have been cloned and demonstrated to control the traits of grain shape (Ja-Hong *et al.*, 2021) which can also be done with other species of interest.

In this study seed shape did not affect the germination rate and percent. However, other studies have demonstrated contrary results to this study in which elongated seeds have had a higher

germination rate and percentage (Bu *et al.*, 2016; Cosyns *et al.*, 2005; Liu *et al.*, 2007) which could probably be due to other endogenous physiological differences with the species considered in this study.

## **Conclusion**

This study documented the indigenous knowledge of plants of Chongwe. It showed that the local people of Chongwe district have rich knowledge about the uses of plants and where they are growing. Eighty-nine plant taxa were documented belonging to 19 families. However, most of the ethnobotanically valued species belong to family fabaceae which makes it prone to over-harvesting compared to other families as it had the highest UR. The findings of this study confirmed the hypothesis that plants with local medicinal uses have the highest ethnobotanical values as they were the most used plants in Chongwe district, providing evidence of extensive use of wild medicinal plants by the local population. This study documented the nine use categories of plants within the local population. Therefore, conservation efforts need to focus on the plants with high cultural value as they are prone to over-harvesting to meet the local people's demand. However, ethnobotany is not sufficient for the conservation of such plants, hence the need for germination strategies.

Therefore, improving the conservation efforts by applying regeneration criterion of handling the seeds by depulping and washing the seeds can improve germination percentage of cultural valued plants. Depulping and washing of seeds affect seedling emergence and germination rate of species differently which can be said to be species dependent due to variation in fruit pulp constituents. However, a generalized evidence from this study showed that germination percentage significantly increased when the seeds were depulped and washed due to the removal

of potential germination inhibitors. From the results of this study, it can also be concluded that seed shape affects seedling emergence as spindle shaped seeds tend to germinate faster than round seeds as such seeds have a relatively larger surface to volume ratio than round seeds. This makes them absorb sufficient water as a germination induce. Germination rate of the germinated plants in this study was affected by the fruit weight as seeds in fruits with low weight had a higher germination rate than those of larger weight which can be explained in terms of potential inhibitors. The larger the fruit weight, the larger the pulp accumulation of potential inhibitor. Therefore, adoption of these regeneration strategies in the studied plant taxa may enhance a quick environmental restoration by reducing seedling emergence time, increasing the rate of germination and increasing germination percentage of high ethnobotanically valued plants which are prone to over-exploitation. This can be done by selecting and planting seeds that are spindle shaped and have low fruit weight within and across the species germinated in this study and then depulping and washing them using water.

### **Recommendation**

In order to conserve the ethnobotanically valued plant species, there is need for recognition and participatory support of local communities in activities directly related to conservation through Community Based Natural Resource Management (CBNRM). For example in some countries such as Zimbabwe, some limited, sporadic and opportunistic attempts to plant medicinal plants are being made by individuals (as single plants around homes and gardens) and organizations (Tree Africa and Commercial Bank of Zimbabwe). The two organizations decided to include plant cultivation to their business. They started with one school each and have since invited botanists to introduce medicinal plant species into the programme and to catalogue plants already planted by the schools (Shumba *et al.*, 2009). This can as well be done in Zambia.

There is also need for more ethnobotanical studies, natural resource assessment and introduction of conservation policies of such plants within communities. For examples policies like national tree planting policies can be introduced as an impact mitigation measure for the over utilized species. The other impact mitigation measure would be the introduction of home gardens that are species-rich agroforestry systems containing many cultivated and wild plants (Whitney *et al.*, 2018). Moreover, home gardens could contain a variety of plants with multiple uses and could be explored for their conservation relevance, for threatened species can be proposed and implemented following the optimal regeneration strategy of plants. There is also need to carry out more research on the effects of other plant functional traits such as seed weight, glucose and abscisic acid levels on germination performance of wild taxa and to also identify other potential germination inhibitors in the fruit pulp and find ways to break seed dormancy that may include scarification. Furthermore, studies on the effect of seed shape and other seed parameters on seed germination within individual species are encouraged to improve the knowledge on the effect of functional traits on seed germination and seedling emergence.

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## Appendix 1: Plant Uses

ACCESSION NUMBERS	BOTANICAL NAME	LOCAL NAME	FAMILY	DATE COLLECTED	USE CATEGORY	USES	CONCOCTION
22307	<i>Pseudolachnostylis maprouneifolia</i> (Pax) Rudd.Sm	Musolo (Tonga)	Phyllanthaceae	16/08/2020			
					Medicinal (MED)	Stomach pain	Water is drunk from the boiled roots/chewing the leaves and sucking the liquid from it.
						Diarrhoea	Water is drunk from the boiled roots/chewing the leaves and sucking the liquid from it.
					Animal Food (AF)	Feed for goats	fruits are soaked in water before feeding the goats
					Energy (EN)	charcoal	
						Firewood	
					Technology and craft (TECH/CRAFT)	construction of huts	
						constructing bridges	
						Making cooking sticks	
						constructing fences	
making furniture							
	making wooden ploughs						
Social (SOC)	Bringing back the spouse	Dry the leaves and smoke whilst mentioning the name of the spouse					
22322	<i>Nerium oleander</i> L.	Musolo (Tonga)	Apocynaceae	16/08/2020	Medicinal (MED)	Stomach pain	
						Diarrhoea	

						Body warmth in women for sexual satisfaction	
					Ornamental (ORN)	planted on people's yards as an ornamental plant	
22300	<i>Julbernardia paniculata</i> J. Lean	Mutondo (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Warming body in women for sexual satisfaction of the partner	the roots are dried, crushed and put in porridge
						Stomach pain	Roots are boiled and the infusion is drunk
					Ornamental (ORN)	planted on people's yards as an ornamental plant	
22374	<i>Burkea africana</i> Hook.	Mulala (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Cough	Roots are soaked then the infusion is drunk
						Heart problems	
					Energy (EN)	Firewood	
						Charcoal	
					Medicinal (MED)	Erectile dysfunction	Roots are soaked then the infusion is drunk
					Energy (EN)	Firewood	
Charcoal							
Technology and craft (TECH/CRAFT)	Making fish traps						
22356	<i>Allophylus africanus</i> P. Beauv	Mulalu, Nchanga luche (Soli, Nyanja)	Sapindaceae	28/08/2020	Medicinal (MED)	Stomach pain	Roots are soaked then the infusion is drunk
					Others (OTH)	Washing away curse	Roots are soaked then the infusion is bathed in the bush
22348	<i>Pterocarpus angolensis</i> DC.	Mukula (Tonga)	Fabaceae	16/08/2020	Energy (EN)		
						Charcoal	
						Firewood	

					Technology and craft (TECH/CRAFT)	Construction of huts and houses	
						making furniture	
22292	<i>Bromus rubens</i> L.	Mubu (Soli)	poaceae	16/08/2020	Medicinal (MED)	Mouth sores	Burn the plant to ashes and then apply the ashes on the sores
						Sore throats	Burn the plant to ashes and lick the ashes
22321	<i>Ximena caffra</i> Sond	Mulele, Muchonfwa (Bemba, Tonga)	Olacaceae	16/08/2020	Medicinal (MED)	Reducing the time for menstruation	Roots are taken depending
					Energy (EN)	Fire wood	
22333	<i>Julbernardia globiflora</i> (Benth.) Troupin	Mumba (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Cough	Roots are boiled in cow milk then drunk
					Energy (EN)	Charcoal	
						Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
						Making furniture	
					Others (OTH)	Being lucky	Carry the branch in the pocket
					CI		
22387	<i>Faidherbia albida</i> (Delile) A.Chev.	Mulyansofu (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Stomach pain	Chewing the fibre of the tree and sucking water out of it
						Diarrhea	
						Abortion	
					Medicinal (MED)	Reducing vaginal size	Fibreis inserted in the vagina for at least three hours
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts	

					Social (SOC)	Finding a spouse	Putting fibre in lotion and applying the whole body after bath	
22331	<i>Ochna puberula</i> N. Robsoni in Bol. Soc.Brot., Ser	Kabwele (Bemba)	Ochnaceae	16/08/2020	Medicinal (MED)	Measles	Leaves are burnt to ashes and then applied	
					Energy (EN)	Fire wood		
					Technology and craft (TECH/CRAFT)	Construction of huts		
22342	<i>Diospyros senensis</i> Klotzsch.	Muchede walekaleka (Tonga)	Ebenaceae	16/08/2020	Medicinal (MED)	Bleeding	Roots are soaked for more than five hours and the infusion drunk	
						Fibroids in women		
						Diarrhoea		
					Human Food (HF)	Fruits are eaten by humans		
22347	<i>Bobgunnia madagascariensis</i> (Desv.)	Mundale (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled and the infusion drunk	
						Diarrhoea		
						Paronychia	Roots are boiled and finger placed in the infusion whilst warm	
						Energy (EN)	Charcoal	
							Fire wood	
						Toxic (TOX)	fish poisoning	
						Technology and craft (TECH/CRAFT)	Construction of huts and houses	
							Making furniture	
Others (OTH)	Pesticide in vegetables (killing especially termites)	seeds are crushed and soaked in water for 24 hours and then sprayed to vegetables						
	To prevent magical theft of meal meal	The fruit is put under the storage container of meal meal						

22312	<i>Brachystegia stipulata</i> De Wild.	Musiwe (Tonga)	Fabaceae	16/08/2020	Energy (EN)	Charcoal Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts Making furniture Source of fibre threads	
22302	<i>Dichrostachys cinerea</i> (L) Wight & Arn	Ngalati, Lukwe (B,T)	Fabaceae	16/08/2020	Medicinal (MED)	Cough Stomach pain Ulcers Deworming Toothache	Roots are boiled and the infusion is drunk Leaves are boiled with salt and then
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Fire wood Charcoal	
					Technology and craft (TECH/CRAFT)	Making furniture Construction of huts	
22337	<i>Securidaca longepedunculata</i> Fresen.	Mufufuma (Soli)	Polygalaceae	16/08/2020	Medicinal (MED)	Snake bite	Roots are crushed and rubbed on the bitten site strongly
					Energy (EN)	Fire wood	
22359	<i>Rhigozum brevispinosum</i> Kuntze	Chilyambela (Tonga)	Bignoniaceae	16/08/2020	Medicinal (MED)	Disappearing testes in men	Roots are soaked in water for about five hours and dried for a week. They are then crushed to powder and the applied on the cuts made around the waist using the blade
22320	<i>Vangueria</i>	Ngayi, Ma	Rubiaceae	16/08/2020	Medicinal (MED)	Heart problems (High	Roots are soaked for five hours and the infusion is drunk

	<i>infausta</i> Burch. Subsp. Infausta	fumo (Nyanja, Tonga)				heart beat and other problems)	
22385	<i>Vangueria discolor</i> (De Wild.) Lantz	Muchende walekaleka (Tonga)	Rubiaceae	16/08/2020	Medicinal (MED)	barrenness	Roots are boiled and the infusion drunk
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Fire wood	
22350	<i>Bauhinia petersiana</i> Bo lle	Mupondo (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled and the infusion drunk
						barrenness	Roots are boiled with roots of <i>Steganotaenia araliacea</i> Hochst and the infusion drunk
					Human Food (HF)	Seeds are eaten by humans	
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts Making furniture	
22297	<i>Lablab purpureus</i> (L.) Sweet Subsp. Uncinatus Verdc. Var. uncinatus	Nsoloka (Soli)	Fabaceae	16/08/2020	Medicinal (MED)	Reducing the vagina size after labour	Roots are soaked in water and then the lady sits in water for at least two hours a day
					Human Food (HF)	Flowers are eaten by humans when mixed in <i>Sesamum angolense</i>	
22351	<i>Boscia integrifolia</i> J. St.-Hil.	Mususu (T)	Caparaceae	16/08/2020	Medicinal (MED)	Waist pain	Roots are boiled of which some infusion is taken orally whilst some is used to massage the waist
					Energy (EN)	Charcoal Fire wood	

					Technology and craft (TECH/CRAFT)	Construction of huts	
						Making furniture	
22325	<i>Trichodesma physaloides</i> A .DC.	Jilebelebe (Tonga)	Boraginaceae	16/08/2020	Medicinal (MED)	Boosting immunity	Soaking the roots for at least five hours and drinking the infusion
						Increasing the size labia minora	Tender shoot is strongly rubbed on the labia minora
					Human Food (HF)	Leaves are eaten as relish by humans	
22306	<i>Phyllanthus fraternus</i> G.L.Webster	Namupikini (Soli)	Phyllanthaceae	16/08/2020	Medicinal (MED)	Erectile dysfunction	Chewing the leaves and sucking its water or Dry the leaves, crush them and put in porridge or tea
						Aphrodisiac	
						Diabetes	Fresh leaves and roots are crushed and soaked in water then the infusion is drunk
22317	<i>Ficus wakefieldii</i> Hutch.	Mupulam pako, Mtowa, Mtawa (Bemba, Tonga, Nyanja)	Moraceae	17/08/2020	Medicinal (MED)	Reducing the vagina size after labour	Root are soaked in water for 5 hours and the woman sits in water for two hours every day for a week
						Malaria	Roots are boiled and the infusion is drunk
						Fever	
						Cough	
					Medicinal (MED)	Hypertension	Leaves are boiled and the infusion is drunk
						Stomach pain	
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by chickens	
					Energy (EN)	Fire wood	
					Technology and	Making furniture	

					craft (TECH/CRAFT)	Construction of huts	
22354	<i>Sericanthe andongensis</i> (Hiern).Robbr	Nthudza (Nyanja)	Rubiaceae	17/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled and the infusion is drunk
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats	
					Energy (EN)	Fire wood	
22375	<i>Desmodium velutinum</i> (Willd.) DC.	Kalambati la (B)	Fabaceae	17/08/2020	Social (SOC)	Bringing back the spouse	Burning the plant to ashes then the ash is applied on the cuts made using the blade around the waist
22380	<i>Flacourtia indica</i> (Burm. f.) Merr.	mutumburwa (Senga)	Salicaceae	17/08/2020	Medicinal (MED)	Pneumonia	Roots are boiled with a needle and the infusion is drunk
						Cleaning the womb after miscarriage	
						Anal ulcer	
						Stomach pain	
						Diarrhoea	
						Deworming	
					Medicinal (MED)	Syphilis	Roots are boiled and the infusion is drunk
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats	
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of foot storage	
22345	<i>Ximenia</i>	Mutundul	Olacaceae	17/08/2020	Medicinal (MED)	Whooping cough	Roots are boiled and the infusion is drunk



					Others (OTH)	Washing away the curse	Roots are soaked in water and the infusion is bathed from the back of the house
22327	<i>Brachystegia boehmii</i> Taub.	Mubombo (Tonga)	Fabaceae	20/08/2020	Medicinal (MED)	Reducing vaginal size after giving birth	Roots are soaked and the patient sits in water for at least 30 minutes in a day for a month
					Energy (EN)	Charcoal	
						Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts and houses	
						Making furniture	
					Others (OTH)	Washing away a curse	
CI							
22376	<i>Dalbergia melanoxylon</i> Guill. & Perr.	Mumba (Tonga)	Fabaceae	20/08/2020	Energy (EN)	Charcoal	
						Fire wood	
					Technology and craft (TECH/CRAFT)	Making furniture	
						Construction of huts	
22305	<i>Grewia stolzii</i> Ulbr	Mulyapw ele (Bemba)	Malvaceae	20/08/2020	Medicinal (MED)	Nausea	Roots are boiled then the infusion drunk
						Erectile dysfunction in men	
						Body warming in women for sexual satisfaction	
						Diarrhoea	
						Stomach pain	
					Human Food (HF)	Fruits are eaten by humans	

					Energy (EN)	Fire wood	
22355	<i>Turraea robusta</i> Gürke	Mufumbwa (Soli)	Meliaceae	19/08/2020	Medicinal (MED)	Cough	Roots are boiled then the infusion drunk
						Stomach pain	
					Energy (EN)	Fire wood	
22339	<i>Pavetta schumanniana</i> F.Hoffm. Ex K. Schum	Zazamw ikulu (Senga)	Rubiaceae	17/08/2020	Medicinal (MED)	Body warming in women for sexual satisfaction	Leaves are dried and Crushed and then put in porridge
						Stomach pain	Roots are soaked in water and the infusion is drunk
						Diarrhoea	
22381	<i>Ipomoea fulvicaulis</i> Boiss. ex Hallier f.	Kalenga (senga)	Convolvulaceae	20/08/2020	Medicinal (MED)	Delayed fontanelle	Burn the plant to ash and then mix the ash in Vaseline and then apply on the fontanelle spot at least twice a day
					Social (SOC)	Finding a spouse	Put a small branch of a plant in lotion the apply everyday
22382	<i>Ricinus communis</i> L.	Imono (Bemba)	Euphrbiaceae	28/08/2020	Medicinal (MED)	Diarrhoea	Roots are soaked in water, then the infusion drunk
						Nausea	Extract the oil from it by burning the seeds and then drink the oil
						Swelling legs	Leaves are warmed and then used to massage the swelling legs
					Technology and craft (TECH/CRAFT)	making lotion	Burning the seeds
						Lighting	
22389	<i>Piliostigma thonningii</i> (Schumacher.) Mil	musekese (Senga)	Fabaceae	16/08/2020	Medicinal (MED)	Nausea	Chewing the leaves and sucking its water
						Stomach pain	Chewing the leaves and sucking its water

	ne-Redh.						Soak the roots and the bark then drink its infusion
						Neck pain	Tie its fibre around the neck until it dries completely
						Sore throats	Roots are boiled then the infusion drunk
						Ulcers	
						Warming body in women for sexual satisfaction	
						Stomach pain	
						barrenness	
						cough	
						Snake bite	
						Increasing Labia minora size in girls	The tender branch is cut in the middle and then used to pull the labia minora until the desired size is reached
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats, Chickens and cattle	
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Making furniture	
					Social (SOC)	To be love by people	
							A small branch is carried in the pocket
22343	<i>Solanum villosum</i> Mill.	Mutuntul wa (Nyanja)	Solanaceae	20/08/2020	Medicinal (MED)	Paronychia	Place the infected finger in the fruit

						Stomach pain	boil the roots and drink its infusion
						Constipation	
						Diarrhoea	
						Constipation in infants	
					Others (OTH)	Termite control	Fruits are crushed and soaked in water for 24 hours and then sprayed to crops or site where there are termites
22308	<i>Ozoroa insignis subsp. reticulata</i> (Baker f.) J.B.Gillett	Mabelema bele (Bemba)	Anacardiaceae	28/08/2020	Medicinal (MED)	Erectile dysfunction Fast healing of wounds	Roots are dried and crushed , then powder put in tea
22303	<i>Gymnosporia senegalensis</i> Loes.	Icimika (Bemba)		20/08/2020	Medicinal (MED)	Syphilis Racing heart	Roots are boiled then the infusion drunk
22361	<i>Amblygonocarpus andongensis</i> (Welw. ex Oliver) Exell & Torre	Musambamfwa, Musiwe (Bemba, Tonga)	Fabaceae	20/08/2020	Energy (EN) Technology and craft (TECH/CRAFT) Others (OTH)	Charcoal Firewood Construction of huts and houses Making furniture Source of fibre threads Washing away the curse	Roots are soaked and then water bathed from the back of the house
22357	<i>Margaritaria discoidea</i> (Baill.) G.L.Webster	kafifi (Nyanja)	Phyllanthaceae	20/08/2020	Others (OTH)	Wash away curse	Roots are boiled then the infusion is bathed in the bush

22352	<i>Combretum molle</i> R.Br. ex G.Don	Kamulya kamuseke, Kalama, Kaunda (Soli, Nyanja, Be mba)	Combretaceae	28/08/2020	Medicinal (MED)	barrenness	Roots are soaked and infusion drunk twice for at least one month
					Energy (EN)	Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
22290	<i>Annona stenophylla</i> Engl & Diels. Subsp. Nana (exell) N.Robson.	Mulolo (Tonga)	Annonaceae	20/08/2020		Hiccup	Roots are soaked in water and then the infusion is drunk
						Anal ulcer	
						Stomach pain	
					Medicinal (MED)	Bola bola	Leaves are dried and crushed and then applied on the cut made by blade on the limbs
					Energy (EN)	Firewood	
22290					Technology and craft (TECH/CRAFT)	Construction of huts and houses	
						Construction of the fence	
22353	<i>Viridivia suberosa</i> J.H. Hemsl. & Verdc	Makande (Tonga)	Passifloraceae	28/08/2020	Medicinal (MED)	relieves menstrual pains	soaking roots and drinking its infusion after 5 hours
					Energy (EN)	Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
22295	<i>Diospyros batocana</i> Hiern	Musangameno, Mukwi, Mufumbo (N,B,T)	Ebenaceae	28/08/2020	Medicinal (MED)	Lunatism	Roots are soaked in water and then the infusion is put in porridge

22365	<i>Steganotaenia araliacea</i> Hochst	Mutebete be, Mutobolo (B, T)	Apiaceae	16/08/2020	Medicinal (MED)	Syphilis	Roots are soaked in water with that of <i>Gymnanthemum amygdalinum</i> (Delile) Sch.Bip. and the infusion drunk	
						Bola bola		
						Tooth ache	Roots are burnt and ashes are put on the affected tooth	
						Urethral infections	Roots are boiled and the infusion is drunk	
						Inducing labour		
						Abortion		
						Others (OTH)	Making a man submissive to a woman	Roots are soaked in water and the infusion mixed menstrual drops is mixed in tea
Luck	A small tender shoot is put in the pocket							
Winning court cases	Putting a small branch in the pocket whilst in court							
22346	<i>Senna singueana</i> (Delile) Lock	Mukeleti (Tonga)	Fabaceae	20/08/2020	Medicinal (MED)	Anal ulcer	Roots boiled , the water from it is drunk and some used to wash the affected part at least twice a day for two weeks	
22330	<i>Hexalobus monopetalus</i> (A. Rich.)	Pasupasu, Futwe (Nyanja, Tonga)	Annonaceae	27/08/2020	Medicinal (MED)	Pneumonia	Tie its fibre around the waist then soak the roots in water and drink its infusion after 5 hours	
						Anal ulcer	Leaves are soaked in water then the infusion is drunk. Some leaves are burnt to ashes and mixed with Vaseline oil and applied on the affected part	
						Human Food (HF)	Fruits are eaten by humans	
22334	<i>Peltophorum africanum</i> Sond.	Mnyele, Chiteta (Nyanja, Bemba)	Fabaceae	27/08/2020	Energy (EN)	Medicinal (MED)	Abortion	Roots are boiled and the infusion drunk
						Firewood	Charcoal	

					Technology and craft (TECH/CRAFT)	Construction of huts	
22304	<i>Mimusops zeyheri</i> Sond.	Nchenja (Soli)	Sapotaceae	27/08/2020	Medicinal (MED)	Stomach pain	Boil the roots and drink its infusion
						Dysentery	
						Diabetes	
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Construction of huts and houses	
Making furniture							
22360	<i>Gardenia subacaulis</i> Stapf & Hutch	Jijulamata nga (Tonga)	Rubiaceae	27/08/2020	Medicinal (MED)	Toothache	Roots are boiled and the infusion is used to rinse the mouth for few minute whilst the infusion is warm
					Animal Food (AF)	seeds are eaten by chickens	seeds are soaked in water before feeding to chickens
					Energy (EN)	Charcoal	
						Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
						Making furniture	
22386	<i>Commiphora mollis</i> Engl.	Musangal uembe (Tonga)	Burseraceae	27/08/2020	Medicinal (MED)	Tooth ache	Boil two roots after tying them together and rinse the mouth with the water whilst warm
						Headache	Barks of the tree are dried and then added to porridge for the patient
						Syphilis	
					Energy (EN)	Fire wood	
					Technology and craft	Construction of huts	

					(TECH/CRAFT)		
22310	<i>Vitex doniana</i> Sweet	Musibi, Mufutu (Tonga, Bemba)	Lamiaceae	20/08/2020	Medicinal (MED)	Syphilis	Roots are dried or burnt to ashes and then applied on the genital organs
						Gonorrhea	
						cough	Roots are soaked in water for at least five hours and the infusion is drunk
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats	
					Energy (EN)	Fire wood	
					Others (OTH)	Washing away the curse	Soaking roots and bathing the water from it
Winning court cases	Putting a small shoot in the pocket whilst in court						
22370	<i>Syzygium guineense</i> (Willd.) DC.	musiniga, Nsafwa (Nyanja, Bemba)	Myrtaceae	27/08/2020	Medicinal (MED)	Stomach pain	Chewing the leaves and sucking its water
							Boil the roots and drink its infusion
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Firewood	
					Technology and craft (TECH/CRAFT)	Construction of bridges	
Construction of huts							
22323	<i>Combretum adenogonium</i> Steud. ex A.R ich.	Mulama (Nyanja)	Combretaceae	27/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled and then the infusion is drunk at least twice a day
						Diarrhoea	
					Energy (EN)	Firewood	

					Technology and craft (TECH/CRAFT)	Construction of huts	
					Others (OTH)	Improving the sale of goods	Putting a small branch in the bag whilst doing business
22367	<i>Combretum zeyheri</i> Sond.	Kandale, Muyongoro (Soli, Tonga)	Combretaceae	27/08/2020	Medicinal (MED)	Stomach pain	Barks of roots and stem are boiled and then the infusion is drunk.
						Nausea	
						Diarrhoea	
						Dysentery	
					Treating wounds	Barks of the stem are dried and crushed into powder and then put on the wound	
						Toothache	Barks of stems are boiled and then the infusion used to rinse the mouth whilst warm.
Energy (EN)	Firewood						
Technology and craft (TECH/CRAFT)	Construction of the huts and houses						
	Making furniture						
22369	<i>Thespesia garckeana</i> F. Hoffm.	Makole (Bemba)	Malvaceae	27/08/2020	Medicinal (MED)	Cough	Roots are boiled then the infusion drunk
						Malaria	
						Fever	
						Stomach pain	
						Ulcers	
						Be witched ailments	

						Diarrhoea	
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
					Others (OTH)	Washing away curse and evil spirits	Barks of both stem and roots are soaked in water and then the infusion is bathed in the bush
22314	<i>Monanthes obovata</i> (Benth.) P.H.Hoekstra	Muchingachinga (Senga)	Annonaceae	16/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled then the infusion drunk
						Diarrhoea	
						Epileps	Roots are soaked in water and the infusion drunk for two weeks
						Body warmth in women for sexual satisfaction	Roots are soaked in water and the infusion drunk
					Human Food (HF)	Fruits are eaten by humans	
					Others (OTH)	washing away a curse and evil spirits	Soak the roots and bath in the bush
22326	<i>Markhamia obtusifolia</i> Sprague	Mutendankwale, Kasanika (Bemba, Nyanja)	Bignoniaceae	24/08/2020	Energy (EN)	Charcoal	
						Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts and houses	
						making furniture	
22384	<i>Gardenia Ternifolia</i> Schumach &	Katunda (Tonga)	Rubiaceae	20/08/2020	Medicinal (MED)	Stomach pain	Leaves are boiled and the infusion is drunk

	Thonn.					Diarrhoea	
					Energy (EN)	Firewood	
					Medicinal (MED)	erectile dysfunction	Roots are soaked in water and the infusion is drunk
					Energy (EN)	Charcoal	
						Firewood	
				Technology and craft (TECH/CRAFT)	Construction of huts		
22328	<i>Flueggea virosa</i> (Roxb. ex Willd.) Rolye	Nyaboye (tonga)	Phyllanthaceae	19/08/2020			
22298	<i>Elephantorrhiza burkei</i> Benth.	Mukalankanga (Tonga)	Fabaceae	16/08/2020	Medicinal (MED)	Treating wounds	Leaves are dried on the frying pan the crushed and applied on the wound
					Medicinal (MED)	Stomach pain	Roots are boiled and the infusion is drunk
					Medicinal (MED)	Waist pain	Roots are boiled and the infusion is drunk
					Energy (EN)	Charcoal	
						Fire wood	
					Technology and craft (TECH/CRAFT)	Making furniture	
						Making bridges	
						Construction of huts and houses	
22296	<i>Pericopsis angolensis</i> (Baker) Meeuwen	Umubanga, Mubanga (Bemba, Tonga)	Fabaceae	27/08/2020			
					Medicinal (MED)	Toothache	Boil the roots and rinse the mouth for few minutes whilst the infusion is warm
					Medicinal (MED)	Paronychia	Boil the roots and place the affected finger for few minutes in the infusion whilst warm
					Medicinal (MED)	Abortion	Boil the roots and leaves, and drink its infusion
					Medicinal (MED)	Stomach pain	
22363	<i>Gymnanthemum amygdalinum</i> (Delile) Sch. Bip.	Mupolopo (Tonga)	Asteraceae	19/08/2020			

						Inducing labour	
						Malaria	
						Fever	
						Gonorrhoea	Roots are soaked in water with that of <i>Steganotaenia araliacea</i> Hochst and the infusion drunk
						Bola bola	
						Syphilis	
22340	<i>Bridelia mollis</i> Hutch	Chizobwa (Senga)	Phyllanthaceae	27/08/2020	Medicinal (MED)	cough	Chewing the fibre and sucking its water
						Stomach pain	
					Energy (EN)	Firewood	
					Technology and craft (TECH/CRAFT)	Construction of huts	
					Making furniture		
22301	<i>Grewia monticola</i> Sond.	chilyabem bela (Tonga)	Tiliaceae	28/08/2020	Medicinal (MED)	Stomach pains	Roots are boiled then the infusion drunk
					Energy (EN)	Firewood	
22316	<i>Baccharoides calvoana</i> subsp. <i>leucocalyx</i> (O.Hoffm.) Isawumi, El-Ghazaly & B.Nord.	Soyo (Tonga)	Compositae	16/08/2020	Medicinal (MED)	Abortion	Leaves are boiled and the infusion is drunk
						Inducing labour	
22362	<i>Parinari curatellifolia</i> Planch. ex Benth.	Mupundu (Bemba)	Chrysobalanaceae	18/08/2020	Medicinal (MED)	Stomach pain	Roots are boiled then the infusion drunk
						Cough	
						Nausea	

						Diarrhoea	
						Toothache	Roots are boiled then the infusion is used to rinse the mouth whilst warm
						Goitre	Roots are burnt to ashes, then applied on small cuts mad on the goitre using a blade. Then infusion from the soaked roots is drunk
						Asthma	Roots are soaked in water for more than five minutes then the infusion is drunk
						Pinguecula and pterygium growths on conjunctiva	Roots are boiled then the infusion drunk and some are used to wash the eye
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Fire wood	
					Technology and craft (TECH/CRAFT)	Making furniture	
						Construction of huts and houses	
					Others (OTH)	Making composite manure	Leaves are buried for two weeks and watered every after two days
22378	<i>Sesamum angolense</i> Welw.	Sope (Nyanja)	Pedaliaceae	18/08/2020		Inducing labour	Roots are soaked then the infusion drunk
					Medicinal (MED)	Diarrhoea	
					Human Food (HF)	Leaves are eaten by humans	
22332	<i>Phyllanthus reticulatus</i> Poir.	Kapululu (Bemba)	Phyllanthaceae	22/08/2020	Medicinal (MED)	Pneumonia	Roots are dried and crushed , then powder applied on the cuts made on the chest using a blade
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Firewood	

22371	<i>Solanum hispidum</i> var. <i>cerrateae</i> J.F. Macbr.	Holifinso	Solanaceae	17/08/2020	Medicinal (MED)	Diarrhoea	Roots and leaves are boiled and the infusion is drunk
						Stomach pain	
						Whooping cough	
						Bilharzia	
						Deworming	
						Diabetes	
						Fever	
						Malaria	
						dysentery	
Ulcers							
22379	<i>Zanha africana</i> (Radlk.) Exell	Chibangalume (Bemba0)	Sapindaceae	18/08/2020	Medicinal (MED)	Headache	Roots are boiled then the infusion is drunk
					Others (OTH)	Awakening the dead bewitched person through lightening	Roots are chewed and spurt on the victims nose
22318	<i>Turraea nilotica</i> Kotschy & Peyr.	Mutunda (Senga)	Melvaceae	17/08/2020	Medicinal (MED)	Compromised immunity in infants	Roots are soaked in water and the infusion is drunk
22293	<i>Ormocarpum Kirkii</i> S. Moore	Magwilinti (Tonga)	Fabaceae	17/08/2020	Medicinal (MED)	Hypertension	Roots are boiled then the infusion drunk
					Human Food (HF)	Diabetes	
						Body warmth in women for sexual satisfaction	
						Fruits are eaten by humans	

					Energy (EN)	Fire wood	
						Stomach pain	
					Medicinal (MED)	Diarrhoea	Roots are boiled then the infusion drunk
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats and Chickens	
					Energy (EN)	Fire wood	
					Ornamental (ORN)	Grown as an ornamental plant	
22368	<i>Ziziphus mauritiana</i> Lam	Masawo (Senga)	Rhamnaceae	27/08/2020			
						Nausea	
						Stomach pain	
						sore throats	Boil the leaves whilst fresh and drink its infusion
					Medicinal (MED)	Fever	Roots are boiled and then infusion is drunk
					Human Food (HF)	Leaves are consumed as tea by humans	Leaves are dried and then boiled as tea
					Others (OTH)	Making a man submissive to a woman	Roots are soaked in water and the infusion mixed menstrual drops is mixed in tea
22344	<i>Fadogia ancylantha</i> Schweinf.	Meso hampongo (Tonga)	Rubiaceae	28/08/2020			
					Medicinal (MED)	Reducing vaginal size	Root barks are crushed and inserted in the vagina for at least three hours a day for two weeks
						Body warmth in women for sexual satisfaction	Roots are boiled and the infusion is drunk
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Firewood	
22294	<i>Bridelia cathartica</i> G. Bertol	Musalalu osagona (Nyanja)	Phyllanthaceae	18/08/2020			

					Technology and craft (TECH/CRAFT)	Construction of huts						
						Making food storage shelters						
22309	<i>Abrus precatorius</i> L.	Akalunguti (Bemba)	Fabaceae	27/08/2020	Medicinal (MED)	Body warmth in women for sexual satisfaction	Roots are boiled with cow milk and then milk is drunk					
						Headache						
						Skin smoothening	Seeds are put in lotion					
											Delayed waking in children	Roots are burnt to ashes together with those of <i>Pterocopsis angolensis</i> , then applied on small cuts mad on the goitre using a blade. Then infusion from the soaked roots is drunk
					Energy (EN)	Firewood						
					Toxic (TOX)	Seeds are poisonous for humans						
					Social (SOC)	To find a spouse	Seeds are put in lotion for applying					
22313	<i>Ochna schweinfurthiana</i> F. Hoffm.	Muyunda (Tonga)	Ochnaceae	28/08/2020	Medicinal (MED)	stomach pain	Roots are boiled and the infusion drunk					
					Technology and craft (TECH/CRAFT)	Fire wood						
22341	<i>Euphorbia tirucalli</i> L.	Lunsonga, Mduze (Bemba, Nyanja)	Euphobiaceae	20/08/2020	Medicinal (MED)	Syphilis	Roots are boiled and the infusion is drunk					
					Toxic (TOX)	Poison for fish	The whole plant is crushed then thrown in the pool of water					
					Technology and craft (TECH/CRAFT)							

22338	<i>Barleria senensis</i> Klotzsch	Milu (Soli)	acanthaceae	23/08/2020	Medicinal (MED)	Stomach pains	Roots are boiled and the infusion is drunk
						Diarrhoea	
					Human Food (HF)	Fruits are eaten by humans	
					Energy (EN)	Firewood	
						Charcoal	
					Technology and craft (TECH/CRAFT)	Making furniture	
22329	<i>Capparis tomentosa</i> Lam	Mulyabali shine (Bemba)	Capparaceae	18/08/2020	Human Food (HF)	Fruits are eaten by humans	Tender branches are put in lotion for applying
					Energy (EN)	Firewood	
					Others (OTH)	Chasing away witches and evil spirits	
22383	<i>Combretum collinum</i> Fresen.	Mufunta (Tonga)	Combretaceae	24/08/2020	Medicinal (MED)	Stomach pains	Leaves are chewed then water is sucked from it, residues are spurt out
						Diarrhoea	
					Medicinal (MED)	Aphrodisiac	Roots are soaked in water and the infusion from it is drunk
					Energy (EN)	Firewood	
						Charcoal	
					Technology and craft (TECH/CRAFT)	Construction of huts	
	Making furniture						
22299	<i>Brachystegia utilis</i> Hutch. & Burt Davy	Kasumbuti (Soli)	Fabaceae	27/08/2020	Energy (EN)	Firewood	Construction of huts and houses
					Technology and craft (TECH/CRAFT)		

					Social (SOC)	Bringing back the spouse	Leaves are dried and smoked whilst mentioning the name of the spouse
22373	<i>Acacia Kirkii</i> Oliv.	Kafifi (Senga)	Fabaceae	28/08/2020	Medicinal (MED)	Paronychia	Fresh leaves are crushed then put on the pricked finger using the thorn from the plant
22358	<i>Triumfetta amuletum</i> Sprague.	Mpanu (Tonga)	Melvaceae	27/08/2020	Medicinal (MED)	Blood boosting	Barks of the tree are boiled in cow milk then drunk
					Human Food (HF)	Fruits are eaten by humans	
					Animal Food (AF)	Fruits are eaten by goats and Chicken	
					Energy (EN)	Firewood	

**Appendix 2: Eighty-nine plant species introduced by the 50 informants**

Species Accession Number	Botanical Name	Local Name	Family	Basic values				Indices				Ranking			
				USE CATEG ORY	FC	UR	NU	CI	RFC	RNU	CV	CI	RFC	RNU	CV
22307	<i>Pseudolachnostylis maprouneifolia</i> (Pax) Rudd.Sm	Musolo (Tonga)	Phyllanthaceae	6	33	93	6	1.86	0.66	0.666667	0.8184	1	2	6	1
22380	<i>Flacourtia indica</i> (Burm F.) Merr	mutumburwa (Senga)	Salicaceae	8	25	79	8	1.58	0.5	0.888889	0.702222	4	5	1	2
22305	<i>Grewia stolzii</i> Ulbr	Mulyapwele (Bemba)	Malvaceae	7	25	90	7	1.8	0.5	0.777778	0.7	3	5	1	3
22389	<i>Piliostigma thorningii</i> (Schumach.) Milne-Redh	musekese (Senga)	Fabaceae	7	24	91	7	1.82	0.48	0.777778	0.679467	2	7	1	4
22369	<i>Pseudolachnostylis maprouneifolia</i> (Pax) Rudd.Sm	Makole (Bemba)	Malvaceae	7	30	39	7	0.78	0.6	0.777778	0.364	7	3	1	5
22293	<i>Ormocarpum Kirkii</i> S. Moore	Magwilinti (Tonga)	Fabaceae	4	28	48	4	0.96	0.56	0.444444	0.238933	6	4	9	6
22368	<i>Ziziphus mauritiana</i> Lam	Masawo (Senga)	Rhamnaceae	7	14	54	7	1.08	0.28	0.777778	0.2352	5	8	1	7
22343	<i>Solanum villosum</i> Mill	Mutuntulwa (Nyanja)	Solanaceae	5	36	20	5	0.4	0.72	0.555556	0.16	15	1	4	8
22294	<i>Bridelia cathartica</i> G. Bertol	Musalalu osagona (Nyanja)	Phyllanthaceae	6	13	21	6	0.42	0.26	0.666667	0.0728	14	9	1	9
22362	<i>Parinari curatellifolia</i> Planch. ex Benth.	Mupundu (Bemba)	Celastraceae	2	9	36	5	0.72	0.18	0.555556	0.072	8	15	3	10
22350	<i>Bauhinia petersiana</i> Subsp. <i>Macrantha</i> (Oliv.) J.H. Ross & Brummitt & J.H. Ross	Mupondo (Tonga)	Fabaceae	4	11	36	4	0.72	0.22	0.444444	0.0704	8	11	5	11
22310	<i>Vitex doniana</i> Sweet	Musibi,	Lamiaceae	6	8	26	6	0.52	0.16	0.666666	0.05546	12	19	1	12

		Mufutu (Tonga, Bemba)								7	7				
22314	<i>Monanthes obovata</i> (Benth.) P.H.Hoekstra	Muchingachinga (Senga)	Annonaceae	6	10	28	4	0.56	0.2	0.444444	0.049778	11	12	4	13
22317	<i>Ficus wakefieldii</i> Hutch.	Mupulampako, Mtowa,Mtowa (Bemba, Tonga, Nyanja)	Moraceae	5	9	24	5	0.48	0.18	0.555556	0.048	13	15	2	14
22335	<i>Diplorhynchus condylocarpon</i> (Mull. Arg)	,Mwenge,Mutowa (Bemba, Tonga)	Apocynaceae	3	10	32	3	0.64	0.2	0.333333	0.042667	10	12	10	15
22387	<i>Faidherbia albida</i> (Delile) A. Chev	Mulyansofu (Tonga)	Fabaceae	4	12	20	4	0.4	0.24	0.444444	0.042667	15	10	3	15
22383	<i>Combretum collinum</i> Fresen.	Mufunta (Tonga)	Chrysobalanaceae	5	9	17	3	0.34	0.18	0.333333	0.0204	17	15	9	17
22370	<i>Syzygium guineense</i> (Willd.) DC.	musiniga, Nsafwa (Nyanja, Bemba)	Myrtaceae	6	5	14	6	0.28	0.1	0.666667	0.018667	20	26	1	18
22290	<i>Annona stenophylla</i> Engl & Diels. Subsp. Nana (exell) N.Robson.	Mulolo (Tonga)	Annonaceae	3	7	17	3	0.34	0.14	0.333333	0.015867	17	21	8	19
22304	<i>Mimusops zeyheri</i> Sond	Nchenja (Soli)	Sapotaceae	4	5	16	4	0.32	0.1	0.444444	0.014222	19	26	2	20
22363	<i>Vernonia amygdalina</i> Del.	Mupolopopo (Tonga)	Asteraceae	3	9	11	3	0.22	0.18	0.333333	0.0132	26	15	7	21
22302	<i>Dichrostachys cinerea</i> (L) Wight & Arn	Ngalati, Lukwe (Bemba, Tonga)	Fabaceae	3	6	14	3	0.28	0.12	0.333333	0.0112	20	22	7	22
22296	<i>Pericopsis angolensis</i>	Umubanga, Mubanga	Fabaceae	3	6	14	3	0.28	0.12	0.333333	0.0112	20	22	7	22

	(Baker) Meeuwen	(Bemba, Tonga)								3					
22386	<i>Commiphora mollis</i> (Oliv.) Engl.	Musangalumbembe (Tonga)	Boraginaceae	2	6	12	3	0.24	0.12	0.333333	0.0096	23	22	7	24
22344	<i>Fadogia ancyclantha</i> Schweinf.	Me Hampongo (Tonga)	Rubiaceae	5	6	11	3	0.22	0.12	0.333333	0.0088	26	22	7	25
22347	<i>Bobgunia madagascariensis</i> (Desv.)	Mundale (Tonga)	Fabaceae	6	3	12	5	0.24	0.06	0.555556	0.008	23	37	1	26
22360	<i>Gardenia subcaulis</i> Stapf & Hutch	Jijulamatanga (Tonga)	Rubiaceae	4	4	9	4	0.18	0.08	0.444444	0.0064	30	32	1	27
22353	<i>Viridivia suberosa</i> J.H. Hemsl. & Verdc	Makande (Tonga)	Passifloraceae	3	5	9	3	0.18	0.1	0.333333	0.006	30	26	5	28
22345	<i>ximenia americana</i> L. Var. <i>microphylla</i>	Mutundula (senga)	Olacaceae	3	4	9	3	0.18	0.08	0.333333	0.0048	30	32	5	29
22378	<i>Sesamum angolense</i> Welw.	Sope (Nyanja)	Pedaliaceae	2	5	10	2	0.2	0.1	0.222222	0.004444	28	26	17	30
22371	<i>Solanum hispidum</i> L.	Holifinso (Soli)	Solanaceae	1	10	10	1	0.2	0.2	0.111111	0.004444	28	12	42	30
22322	<i>Nerium oleander</i> L.	Musolo (Tonga)	Apocynaceae	2	8	12	1	0.24	0.16	0.111111	0.004267	23	19	42	32
22309	<i>Abrus precatorius</i> Linn	Akalunguti (Bemba)	Fabaceae	4	3	7	4	0.14	0.06	0.444444	0.003733	35	37	1	33
22328	<i>Flueggea virosa</i> (Roxb. ex Wild.) Voigt	Nyaboye (tonga)	Phyllanthaceae	3	3	9	3	0.18	0.06	0.333333	0.0036	30	37	4	34
22338	<i>Berberia senensis</i> Klotzsch	Milu (Soli)	Acanthaceae	4	2	9	4	0.18	0.04	0.444444	0.0032	30	49	1	35
22365	<i>Steganotaenia araliacea</i> Hochst	Mutebetebe, Mutobolo (Bemba, Tonga)	Apiaceae	2	5	6	2	0.12	0.1	0.222222	0.002667	36	26	14	36
22315	<i>Dalbergia nitidula</i> Welw. Ex Baker	Mudima (Tonga)	Fabaceae	4	5	6	2	0.12	0.1	0.222222	0.002667	36	26	14	36

22330	<i>Hexalobus monopetalus</i> (A. Rich.)	Pasupasu, Futwe (Nyanja, Tonga)	Annonaceae	3	3	6	3	0.12	0.06	0.333333	0.0024	36	37	3	38
22351	<i>Boscia angustifolia</i> A. Rich	Mususu (Tonga)	Burseraceae	3	3	6	3	0.12	0.06	0.333333	0.0024	36	37	3	38
22298	<i>Elephantorrhiza burkei</i> Benth.	Mukalankanga (Tonga)	Fabaceae	2	4	5	2	0.1	0.08	0.222222	0.001778	47	32	12	40
22299	<i>Brachystegia utilis</i> Hutch. & Burt Davy	Kasumbuti (Soli)	Fabaceae	4	2	5	4	0.1	0.04	0.444444	0.001778	47	49	1	40
22352	<i>Combretum molle</i> R. Br.	Kamulya kamuseke, Kalama, Kaunda (Soli, Nyanja, Bemba)	Combretaceae	3	3	6	2	0.12	0.06	0.222222	0.0016	36	37	11	42
22323	<i>Combretum adegonium</i> Stend. ex A. Rich	Mulama (Nyanja)	Combretaceae	3	2	6	3	0.12	0.04	0.333333	0.0016	36	49	2	42
22367	<i>Combretum zeyheri</i> Sond.	Kandale, Muyongoro (Soli, Tonga)	Combretaceae	3	2	6	3	0.12	0.04	0.333333	0.0016	36	49	2	42
22333	<i>Julbernardia globiflora</i> (Benth)	Mumba (Tonga)	Fabaceae	4	3	6	2	0.12	0.06	0.222222	0.0016	36	37	9	42
22312	<i>Brachystegia stipulata</i> De Wild.	Musiwe (Tonga)	Fabaceae	2	3	6	2	0.12	0.06	0.222222	0.0016	36	37	9	42
22376	<i>Dalbergia nyasae</i> Baker F.	Mumba (Tonga)	Fabaceae	2	3	6	2	0.12	0.06	0.222222	0.0016	36	37	9	42
22382	<i>Ricinus Communis</i> L.	Imono (Bemba)	Euphrbiaceae	2	3	5	2	0.1	0.06	0.222222	0.001333	47	37	9	48
22329	<i>Capparis tomentosa</i> Lam	Mulyabalishine (Bemba)	Caparaceae	3	2	4	3	0.08	0.04	0.333333	0.001067	50	49	2	49
22358	<i>Triumfetta amuletum</i> Sprague.	Mpanu (Tonga)	Melvaceae	4	1	6	4	0.12	0.02	0.444444	0.001067	36	68	1	50

22384	<i>Gardenia Ternifolia</i> Schumach & Thonn. Subsp. Jovis-tonantis (Welw) Verdc.	Katunda (Tonga)	Rubiaceae	2	3	4	2	0.08	0.06	0.22222 2	0.00106 7	50	37	7	50
22373	<i>Acacia Kirkii</i> Oliv.	Kaffi (Senga)	Fabaceae	3	2	3	3	0.06	0.04	0.33333 3	0.0008	58	49	1	52
22308	<i>Azorea reticulata</i> (Bak. F) R. et A. Fernandes	Mabelemabele (Bemba)	Anacardiaceae	1	4	4	1	0.08	0.08	0.11111 1	0.00071 1	50	32	22	53
22375	<i>Desmodium velutinum</i> (Willd) DC.	Kalambatila (B)	Fabaceae	1	4	4	1	0.08	0.08	0.11111 1	0.00071 1	50	32	22	53
22327	<i>Brachystegia boehmii</i> Taub.	Mubombo (Tonga)	Fabaceae	2	2	4	2	0.08	0.04	0.22222 2	0.00071 1	50	49	6	53
22356	<i>Allophylus cataractrum</i> Bak. F	Mulalu, Nchangaluche (Soli, Nyanja)	Sapindaceae	2	2	4	2	0.08	0.04	0.22222 2	0.00071 1	50	49	6	53
22301	<i>Grewia monticola</i> Sond.	chilyabembelle (Tonga)	Tiliaceae	2	2	4	2	0.08	0.04	0.22222 2	0.00071 1	50	49	6	53
22303	<i>Gymnosporia senegalensis</i> (Lam) loes	Icimika (Bemba)	Capparaceae	3	2	3	2	0.06	0.04	0.22222 2	0.00053 3	58	49	6	58
22297	<i>Lablab purpureus</i> (L.) Sweet Subsp. Uncinatus Verdc. Var. uncinatus	Nsoloka (Soli)	Fabaceae	2	2	3	2	0.06	0.04	0.22222 2	0.00053 3	58	49	6	58
22361	<i>Amblygonocarpus andogensis</i> (Welw. ex Olive) Exell & Torre	Musambamfwa, Musiwale (Bemba, Tonga)	Fabaceae	2	2	3	2	0.06	0.04	0.22222 2	0.00053 3	58	49	6	58
22355	<i>Turraea robusta</i> Guemle	Mufumbwa (Soli)	Meliaceae	2	2	3	2	0.06	0.04	0.22222 2	0.00053 3	58	49	6	58
22337	<i>Securidaca longepedunculata</i> Fresen.	Mufufuma (Soli)	Polygalaceae	1	3	4	1	0.08	0.06	0.11111 1	0.00053 3	50	37	15	58
22374	<i>Burkea africana</i> Hook.	Mulala (Tonga)	Fabaceae	3	1	3	3	0.06	0.02	0.33333 3	0.0004	58	68	1	63
22334	<i>Peltophorum africanum</i> Sond.	Mnyele, Chiteta	Fabaceae	3	1	3	3	0.06	0.02	0.33333 3	0.0004	58	68	1	63

		(Nyanja, Bemba)													
22331	<i>Ochna puberula</i> N. Robsoni in Bol. Soc.Brot., Ser	Kabwele (Bemba)	Ochnaceae	3	1	3	3	0.06	0.02	0.33333 3	0.0004	58	68	1	63
22340	<i>Bridelia mollis</i> Hutch	Chizobwa (Senga)	Phyllanthaceae	3	1	3	3	0.06	0.02	0.33333 3	0.0004	58	68	1	63
22332	<i>Phyllanthus reticulatum</i> Poir.	Kapululu (Bemba)	Phyllanthaceae	3	1	3	3	0.06	0.02	0.33333 3	0.0004	58	68	1	63
22381	<i>Ipomoea fulvicaulis</i> (Hochst. ex choisy)	Kalenga (senga)	Convolvulaceae	2	2	2	2	0.04	0.04	0.22222 2	0.00035 6	69	49	1	68
22357	<i>Phyllanthus discoideus</i> Mill.	kafifi (Nyanja)	Phyllanthaceae	2	2	2	2	0.04	0.04	0.22222 2	0.00035 6	69	49	1	68
22306	<i>Phyllanthus fratenus</i> Web.	Namupikinini (Soli)	Phyllanthaceae	1	2	3	1	0.06	0.04	0.11111 1	0.00026 7	58	49	8	70
22326	<i>Markhamia obstusifolia</i> (Baker)	Mutendankwale, Kasanika (Bemba, Nyanja)	Asteraceae	1	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71
22325	<i>Trichodesma physaloides</i> (Fenzl)	Jilebelebe (Tonga)	Bignoniaceae	1	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71
22342	<i>Diospyros senensis</i> Klotzsch.	Muchede walekaleka (Tonga)	Ebenaceae	2	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71
22341	<i>Euphorbia tirucalli</i> L.	Lunsonga, Mduze (Bemba, Nyanja)	Euphobiaceae	2	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71
22300	<i>Julbernardia paniculata</i> J. Lean	Mutondo (Tonga)	Fabaceae	2	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71
22318	<i>Turraea nilotica</i> Kotschy & Peyr.	Mutunda (Senga)	Melvaceae	1	2	2	1	0.04	0.04	0.11111 1	0.00017 8	69	49	3	71
22313	<i>Ochna schweinfurthiana</i> F. Hoffm	Muyunda (Tonga)	Ochnaceae	2	1	2	2	0.04	0.02	0.22222 2	0.00017 8	69	68	1	71

22292	<i>Anisantha rubens</i> (L)		poaceae	1	2	2	1	0.04	0.04	0.111111	0.000178	69	49	2	71
22385	<i>Tapiphyllum discolor</i> Robyns	Muchendewa lekaleka (Tonga)	Rubiaceae	2	1	2	2	0.04	0.02	0.222222	0.000178	69	68	1	71
22354	<i>Sericanthe andongensis</i> (Hiern)Robbr	Nthudza (Nyanja)	Rubiaceae	1	2	2	1	0.04	0.04	0.111111	0.000178	69	49	1	71
22321	<i>Ximenia caffra</i> Sond. Var. <i>caffra</i>	Mulele, Muchonfwa (Bemba, Tonga)	Olacaceae	2	1	2	1	0.04	0.02	0.111111	8.89E-05	69	68	1	81
22320	<i>Vangueria infausta</i> Burch. Subsp. <i>Infausta</i>	Ngayi, Mafumo (Nyanja, Tonga)	Rubiaceae	1	1	2	1	0.04	0.02	0.111111	8.89E-05	69	68	1	81
22359	<i>Rhigozum brevispinosum</i> Kuntze	Chilyabembele (Tonga)	Bignoniaceae	2	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22316	<i>Vernonia leucocarlyx</i> O. Hoffm	Soyo (Tonga)	Combretaceae	3	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22295	<i>Diospyros batocana</i> Hiern	Musangameno, Mukwi, Mufumbo (Nyanja, Bemba, Tonga)	Ebenaceae	1	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22348	<i>Pterocarpus angolensis</i> DC.	Mukula (Tonga)	Fabaceae	1	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22346	<i>Senna singueana</i> (Delile) Lock	Mukeleti (Tonga)	Fabaceae	1	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22339	<i>Pavetta schumanniana</i> F.Hoffm. Ex K. Schum	Zazamwa ikulu (Senga)	Rubiaceae	1	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83
22379	<i>Zanha africana</i> (Radlk.) Exell	Chibangalume (Bemba)	Sapindaceae	1	1	1	1	0.02	0.02	0.111111	4.44E-05	83	68	1	83

### Appendix 3: Questionnaire used in ethnobotanical survey

**THE UNIVERSITY OF ZAMBIA**  
**SCHOOL OF NATURAL SCIENCES**  
**DEPARTMENT OF BIOLOGICAL SCIENCES**  
**P.O BOX 32379**  
**LUSAKA, ZAMBIA**

Dear Respondent,

I am a Student at the University stated above carrying out a study on the Consequences of Functional Traits on Seed Germination and Seedling Emergence in Selected Indigenous Tree Species, and their Ethnobotanical Values.

Your area has been chosen to be one of the study sites and please note that your responses are for research purposes only.

#### **Personal information of informants**

1) Gender

a) Male  b) Female

2) Age distribution

(a) Below 25 years  (b) 26-35  (c) 36-45  (d) Above 45

3) Village: \_\_\_\_\_

4) Chief: \_\_\_\_\_

5) Place of birth: \_\_\_\_\_

6) Educational background

a) Primary  b) Secondary  c) College  d) University

7) What is your occupation?

a) Civil servant

b) Businessman

c) Farmer

d) Other (specify).....

8) Do you know any indigenous plants and their uses within Chongwe?

If no the interview is terminated

If yes fill the table below

Plant #	Use Category	Use(s)

9) Where were you during the following period?

Childhood (1-12yrs) place: \_\_\_\_\_

Teens age (13-19yrs) place: \_\_\_\_\_

Adult age place (above 19 years): \_\_\_\_\_

10) What is your source of knowledge of the ethnobotanical use(s) mentioned in question 8 above

11) Do you apply any method to conserve the plant

12) What method do you use to ensure the plant is conserved?

13) What is the fruiting period of the plant(s) mentioned in question 8 above?

Plant Number	Fruiting Period

14) In which areas within which they are found