

## Review Article

# Other Uses of *Rhynchosia* Roots Other Than For Processing Traditional Fermented Beverages in Zambia

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## Abstract

*Rhynchosia* roots commonly known as *Munkoyo* roots in Zambia are an important ingredient in the processing of cereal-based traditional fermented beverages called *Munkoyo* and *Chibwantu*. *Rhynchosia* roots supply amylase enzymes that hydrolyze gelatinized starch into fermentable sugars to facilitate spontaneous fermentation by lactic acid bacteria. Apart from processing *Munkoyo* and *Chibwantu* beverages, *Rhynchosia* roots have been used for other purposes in rural areas. A survey conducted in Kitwe, Chipata, Choma and Mumbwa revealed that sweet potatoes, wheat flour and sorghum malt are potential alternatives to provide amylase enzymes. *Rhynchosia* root extract is also used as traditional medicine to cure diarrhea, yellow fever and used as contraceptives. Breast feeding mothers with difficulties to produce breast milk use fermented *Munkoyo* and *Chibwantu* to induce lactation. This is because of biochemical changes that take place during fermentation. Chemical analysis of *Rhynchosia* root extract found *Lycorenana*, *Anthracene*, *Phthalic acid*, *Xanthine*, *Quinoline*, *hydrocinnamic acid* and *Acetamide* present as phytochemical compounds. In particular *Xanthine*, *Quinoline* and *acetamide* are known to have antibacterial effects. This may explain why *Rhynchosia* root extract has been used as traditional medicine.

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**Keywords:** Chibwantu; Galactagogues; Medicine; Munkoyo; *Rhynchosia* roots

## Introduction

*Rhynchosia* plant species are wild shrubs that grow in rocky-mountainous regions of Southern Africa. The *Rhynchosia* plant species are endemic to Zambia, the Democratic Republic of Congo, Zimbabwe, Angola, Tanzania, Malawi, Namibia, Botswana and Mozambique [1]. They are also a native dominant shrub in the region between Lake Tanganyika and Lake Mweru [2]. There are different species within *Rhynchosia* genus [3]. *Rhynchosia heterophylla* specie in particular is an erect perennial plant producing a cluster of woody stems growing from a stout woody root stock [4]. This specie is harvested particularly for its root that is an important ingredient in processing popular non-alcoholic beverages in Zambia known as *Munkoyo* and *Chibwantu* [5].

*Munkoyo* and *Chibwantu* beverages are processed by cooking maize meal porridge until gelatinization. When the porridge cools to temperatures below 50°C, *Rhynchosia* roots are added to the porridge. The *Rhynchosia* root contains amylase enzymes that hydrolyzes the gelatinized starch into fermentable sugars like glucose, maltose and maltotrioses [6,7]. The availability of these fermentable sugars facilitates spontaneous fermentation by lactic acid bacteria to produce *Munkoyo* and *Chibwantu* beverages [8].

Other than processing *Munkoyo* and *Chibwantu* beverages, the *Rhynchosia* root extract have also been utilized for other purposes. In rural villages, *Munkoyo* and *Chibwantu* beverages are used for maternal health intervention to induce lactation to mothers who have difficulties producing breast milk. In other rural communities the *Rhynchosia* root extract is traditional medicine for diarrhea and yellow fever, whilst other women use the same extract as contraceptives [9].

Despite all these fore-mentioned beneficial applications of *Rhynchosia* root extract, no scientific research has been done to verify these reports. This research thus carried out a survey involving local traders of *Rhynchosia* roots, processors and consumers of *Munkoyo* and *Chibwantu* beverages, specifically to know other uses of *Rhynchosia* roots other than as an ingredient in the processing of *Munkoyo* and *Chibwantu* Beverages.

## Methodology

### Baseline survey

A baseline survey was conducted in Zambia in the Copperbelt Province (Kitwe), Eastern Province (Chipata), Southern Province (Choma) and Central Province (Mumbwa). Figure 1 is the map of Zambia showing the towns where the survey was conducted.

The survey targeted traders of *Rhynchosia* roots and processors of *Munkoyo* and *Chibwantu* in these towns. During the survey, questionnaires were administered and samples of different types of *Munkoyo* roots were collected for processing of *Munkoyo* samples for laboratory analysis.

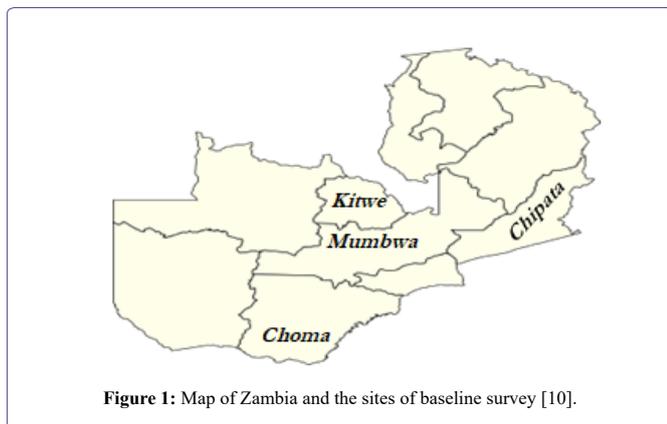


Figure 1: Map of Zambia and the sites of baseline survey [10].

The questionnaires investigated different types of *Rhynchosia* roots used in the processing of *Munkoyo* and *Chibwantu*, possible alternatives to *Rhynchosia* roots for processing *Munkoyo* and *Chibwantu*, medicinal application of *Rhynchosia* roots and traditional use of *Munkoyo* and *Chibwantu* beverages as galactagogues for maternal health benefits for breast feeding mothers. Between 40 and 50 questionnaires were administered to each of the four (4) towns coming to a total of 187 questionnaires together. The data obtained from the questionnaires was analyzed using (Statistical Package for Social Sciences (SPSS) to determine the significant differences in the response of the respondents on the other uses of *Rhynchosia* root other than for processing *Munkoyo* and *Chibwantu* beverages.

### Sample collection

Samples of *Rhynchosia* roots were bought from the traders and processors after responding to the questionnaires in the fore mentioned towns. The target was to obtain as many different types of yellow and white *Rhynchosia* roots as possible for spontaneous fermentation of *Munkoyo*, analysis of pH, Titratable acidity and determining Phytochemicals found in *Rhynchosia* root extract. A total of 60 yellow and white *Rhynchosia* roots were collected from the 4 towns for laboratory analysis.

### Sample preparation

A bunch of *Rhynchosia* roots weighing approximately 50g were soaked in ten (10) different clean jar cups with 2L of water for 24 hours to allow complete extraction of all possible water-soluble chemical compounds and enzymes.

Approximately 1.5L of porridge at warm temperature (45°C-55°C) was added in ten (10) calabashes and added 500ml of *Rhynchosia* root extract previously soaked for 24 hrs. Stirred the mixture of the porridge and then added the extract and left it to ferment for 72 hrs. Samples of *Rhynchosia* root extract and *Munkoyo* which was fermented for 72 hours were collected for analysis in the Laboratory.

### Laboratory analysis

Ten (10) samples of *Rhynchosia* root extract previously soaked in the jar cups and another ten (10) samples of *Munkoyo* samples fermented for 72hrs were taken to University of Zambia, Department of Food Science and Nutrition for analysis of pH and Titratable acidity. Titratable acidity was determined by titrating 10 cm<sup>3</sup> of the samples against sodium hydroxide with phenolphthalein as an indicator [11].

Two (2) samples of white root extract and two (2) other samples of yellow root extract selected at random from the ten (10) roots earlier soaked in the jar cups were taken to Zambia Bureau of Standards (ZABS), for analysis of phytochemicals in *Rhynchosia* root extract. Using Gas Chromatography - Mass Spectrometry (GC-MS), the phytochemicals in the roots were analyzed as follows.

30ml of sample was collected and placed into a separating funnel to which 20 ml of ethyl acetate was added to extract the molecules of interest. Organic phase was collected in a flask to which 5g of sodium sulphate was added. The extraction of the sample was repeated with two portions of ethyl acetate, organic phase was added to the earlier collection. The organic phase was filtered and filtrate collected. The filtrate was then concentrated on Rotary Evaporator to about 2ml, transferred into a glass vial. The glass vial was then taken for analysis on a GC-MS Column temperature was set at 50°C; injection temperature was set at 250°C, with a split less Injection Mode with a sampling time of 1 minute. Flow Control Mode was linear velocity. Pressure set at 88.0 Kpa. Total Flow was 11.0 ml/minute. Column flow was 1.50ml/minute. Linear velocity was 44.4 cm/second. Purge flow set at 3.0. Slit Ratio was -1.0 Temperature programming: 50°C ramped to 150°C at 2°C with holding time of 10 minutes. After which ramped at 4°C to 300°C held for 1minute. Type of column used: TR-50M, thickness 0.25um, length 30.0m and diameter 0.25mm (2.5um). Ion Source was set at 220°C. Interface Temp – 280°C. Solvent cut time at 2 minutes Start mz at 40mz, End mz at 480.

### Results and Discussion

Analysis of the 187 questionnaires administered in the four towns revealed Four (4) different alternatives to *Rhynchosia* roots for processing *Munkoyo* and *Chibwantu* beverages. The commonly used are the sweet potatoes in the Southern Province (Choma) about 10%, compared to the least used in Kitwe less than 5%. On the other hand, Sorghum malt is commonly used in Copperbelt Province (Kitwe) about 40% compared to least used in Southern Province (Choma) less than 4% as indicated in Figure 2.

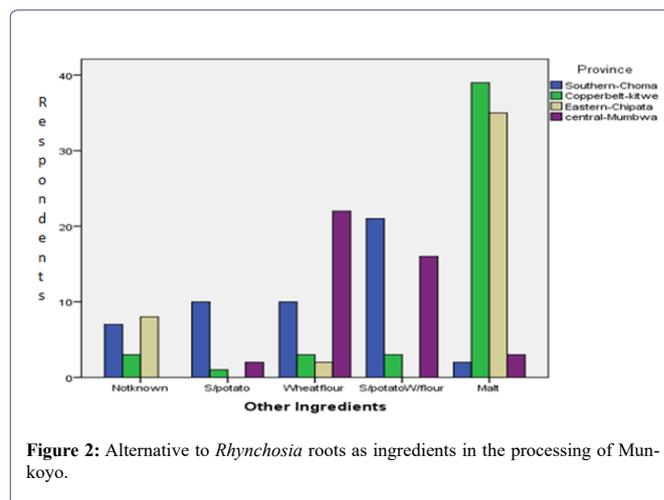


Figure 2: Alternative to *Rhynchosia* roots as ingredients in the processing of *Munkoyo*.

This result shows that sweet potatoes, wheat flour or malt are potential alternatives to *Rhynchosia* roots for processing *Munkoyo* and *Chibwantu*. Incorporation of selected strains of lactic acid bacteria to these alternatives to *Rhynchosia* roots can result into controlled and desirable fermentation of processing *Munkoyo* and *Chibwantu* rather than spontaneous fermentation.

Other than as an ingredient in the processing of *Munkoyo* and *Chibwantu* beverages, *Rhynchosia* root extract is also used as medicine. All the towns where the research was been done expressed knowledge of using the *Rhynchosia* root or its extract as medicine with Copperbelt and Eastern Provinces recording the highest frequency of 33% each and Southern Province (Choma) and Central Province (Mumbwa) with the least frequency of 19% and 15% respectively. *Munkoyo* and *Chibwantu* beverages on the other hand are occasionally used for maternal health intervention to induce lactation to breast feeding mothers in Southern and Central Provinces as depicted in figure 3.

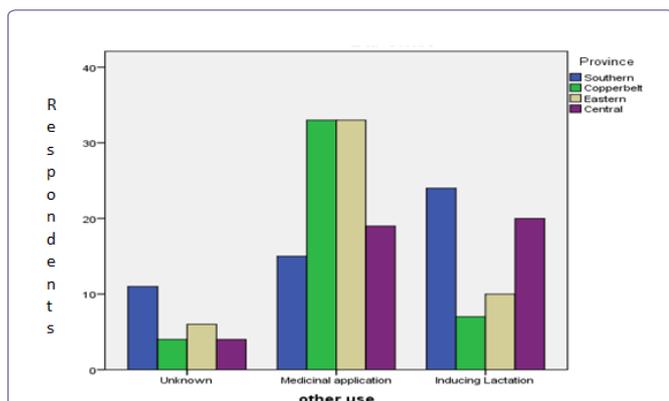


Figure 3: Medicinal application of *Rhynchosia* root and Munkoyo beverage used to induce lactation.

Diseases identified to be cured by *Rhynchosia* root extract include diarrhea, yellow fever and used as contraceptives as shown in figure 4.

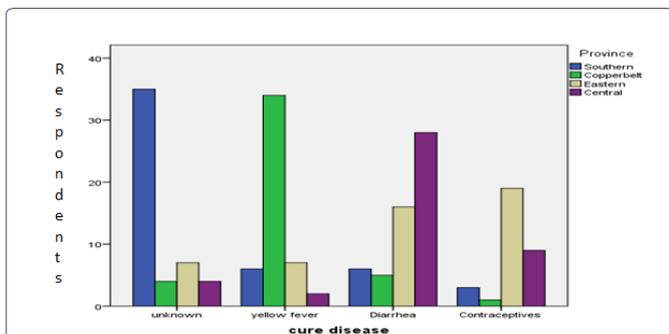


Figure 4: Disease cured by *Rhynchosia* root extract are yellow fever, diarrhea and as contraceptives.

Southern Province recorded low knowledge of *Rhynchosia* root extract as traditional medicine or contraceptives, whilst Copperbelt province frequently use the *Rhynchosia* root extract to cure yellow fever, Central province uses the roots to cure diarrhea and Eastern province use the roots as contraceptives.

There are two types of *Rhynchosia* roots that are distinguished by their appearance and color. The yellow *Rhynchosia* roots is common in the Copperbelt Provinces used for processing *Munkoyo* beverage and the white *Rhynchosia* root for processing *Chibwantu* beverage as shown in figure 5.

The white *Rhynchosia* roots are geographically abundant in the Southern and Central provinces, whilst the yellow *Rhynchosia* roots are common in Copperbelt and Eastern provinces.

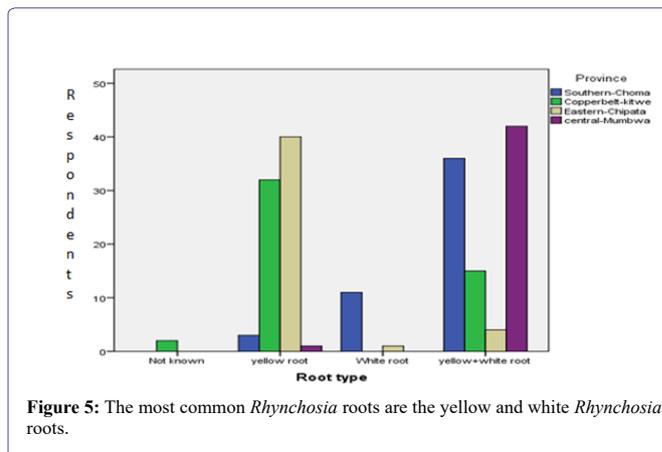


Figure 5: The most common *Rhynchosia* roots are the yellow and white *Rhynchosia* roots.

The pH and corresponding titratable acidity of *Rhynchosia* root extract produced non-uniform but slightly acidic pH range fluctuating around 5.5 and titratable acidity around 0.1%.

This is possibly due to an inherent pH or titratable acidity characteristic of *Rhynchosia* roots fostered by the climatic or environmental conditions in which the *Rhynchosia* plant grows [12]. However, the pH range and titratable acidity of *Munkoyo* beverages were uniform around 3.5 and 0.85% respectively, produced by the accumulation of lactic acid during fermentation as shown in figure 6.

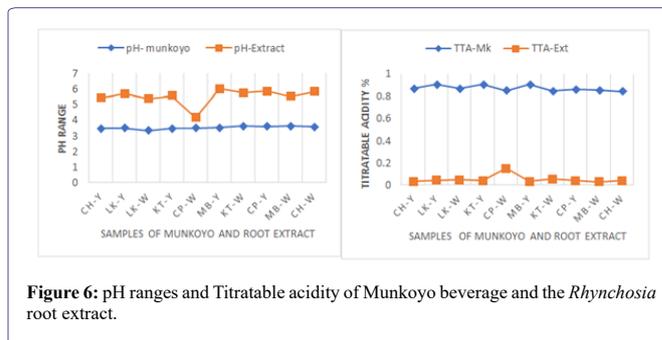


Figure 6: pH ranges and Titratable acidity of Munkoyo beverage and the *Rhynchosia* root extract.

A statistical analysis of the pH range and titratable acidity of fermented *Munkoyo* beverages against *Rhynchosia* root extract was significantly different with a p-value of 0.01.

Gas Chromatography – Mass Spectrometry (GC-MS) analysis of phytochemicals in the white and yellow *Rhynchosia* root extract, identified seven (7) different phytochemicals as indicated in Table 1 below.

The yellow *Rhynchosia* root extract from the Copperbelt Province (Kitwe-KT -Y-TI-38437/4) contained *Xanthine*, *Quinoline* and *Acetamine* except the white *Rhynchosia* root extract from the Southern Province (Choma- CH-W-TI-38437/1) which contained *Lycorenana* and *Anthracene* only.

The venn diagram in figure 7 gives a summary of distribution of the phytochemicals present in yellow *Rhynchosia* root extract abundant in Kitwe and white *Rhynchosia* root extract abundant in Choma, with *Phthalic acid* found in all the root extracts including Mumbwa (MB-W-TI-38437/2) and Chipata (CP-Y-TI-38437/3).

Phytochemicals	CH-W-TI-38437/1	MB-W-TI-38437/2	CP-Y-TI-38437/3	KT-Y-TI-38437/4
Lycorenana	√	x	x	x
Anthracene	√	x	x	x
Phthalic acid	√	√	√	√
Xanthine	x	x	√	√
Quinoline	x	x	√	√
Hydrocinnamic acid	x	√	√	√
Acetamide	x	x	√	√

Table 1: Phytochemicals present in the white and yellow *Rhynchosia* roots.

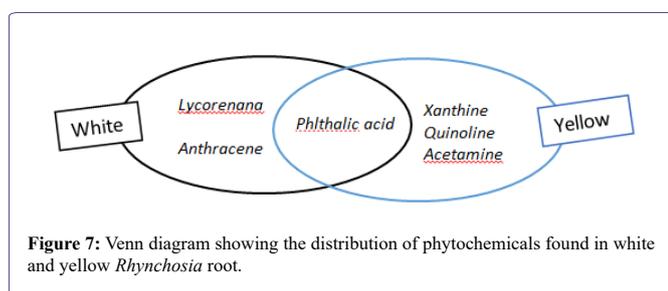


Figure 7: Venn diagram showing the distribution of phytochemicals found in white and yellow *Rhynchosia* root.

## Discussion

*Rhynchosia* plant is a wild native shrub that has not been domesticated but known to be endemic to Southern Africa and the region around Lake Tanganyika and Lake Mweru [13]. This root has not been domesticated yet. This implies that continuous harvest of *Rhynchosia* root for processing cereal-based beverages or medicinal application is leading to the extinction of *Rhynchosia* root species. Thus, the potential for sweet potatoes, malt and wheat flour to be used as alternatives to *Rhynchosia* roots for processing cereal-based beverages is worthy further studies.

Generally, the yellow *Rhynchosia* root is used for processing Munkoyo in the Eastern Province (Chipata) and Central Province (Mumbwa), whilst the white *Rhynchosia* roots are mostly used to process Chibwantu in the Southern Province (Choma).

Yellow *Rhynchosia* root is basically named after deep yellow extract it produces when soaked in water. The deep yellow extract is as a result of the Phenolic, flavonoids and iso- flavonoid compounds abundant in yellow *Rhynchosia* roots than in white *Rhynchosia* roots [12]. In this research the yellow *Rhynchosia* root extract contained Xanthine, Quinoline and Acetamide. These compounds are known to have antioxidants and anti-inflammatory effects. For example Quinoline and Acetamide derivative compounds like *N*-(1-oxo-3,4-dihydro-pyrazino[1,2-*a*] indo-1-(2*H*)-yl-quinoline-8-sulfonamide and *N*-(3,4-dihydro-1-oxopyrazino[1,2-*a*]indo(-1(2*H*)-yl-2-morpholino-acetamide exhibit antibacterial activity against *E.coli*, *P.aeruginosa*, *Staphylococcus aureas* and *S. Pyogenes strains* [14]. Xanthine on the other hand as a compound in medicinal plants, exists in various forms as caffeine, theophylline, theobromine in coffee, tea or cocoa. Xanthine has diverse pharmaceutical applications as Cyclic nucleotide, Phosphodiesterase inhibition, antagonizing adenosine receptor, anti-inflammatory, anti- microbial, anti-oxidant and anti- tumor activity [13]. This may explain why the extract of yellow *Rhynchosia* root is commonly used as medicine in the Copperbelt Province (Kitwe),

Central Province (Mumbwa) and Eastern Province (Chipata) to cure yellow fever, diarrhea or used as contraceptives respectively.

Interesting to note that Southern Province (Choma), where white *Rhynchosia* roots are geographically abundant show low preference of using *Rhynchosia* root as medicine. The white *Rhynchosia* root extract exclusively contained *Lycorenana* and *Anthracene* which has no researched medicinal application. This too explains why the white *Rhynchosia* root is not utilized as traditional medicine compared to the yellow *Rhynchosia* root.

Munkoyo and Chibwantu beverages on the other hand are commonly used for maternal health intervention in Choma. Munkoyo and Chibwantu beverages are known to induce lactation, hence known as galactogogues. Galactogogues are synthetic or plant molecules used to induce, maintain and increase milk production both in human clinical condition and production of milk in the animal dairy industry [14]. Mothers with challenges with breast feeding their young ones are administered Munkoyo or Chibwantu to induce lactation. This has been helpful to those who are resource marginalized in villages or cannot afford conventional medication to induce lactation.

## Conclusion

Munkoyo and Chibwantu are popularly processed as social beverages to provide energy. However, in rural communities the beverages are also used as maternal health beverage (galactogogues). Equally, *Rhynchosia* root and its extract is a very important ingredient in the processing of Munkoyo and Chibwantu but also used as traditional medicine to cure yellow fever, diarrhea and as contraceptives. None domestication of *Rhynchosia* root thus far pose a threat of quick extinction although identified alternatives to *Rhynchosia* roots to process Munkoyo beverage (Malt, wheat flour) or Chibwantu beverages (Sweet potatoes) will be good for further research. This research has further given insight to other uses of Munkoyo and Chibwantu as health beverages whilst *Rhynchosia* root and its extract for further research as traditional medicinal application.

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