Promoting Indigenous Fruit in Namibia

FINAL REPORT

regarding further work done on

Baobab

submitted to the

Indigenous Plant Task Team

by

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1. Background

Baobab (*Adansonia digitata*) was included in Phase One of the Promoting Indigenous Fruit (PIF) project as a “second team” species, and was also one of four “first generation” focal species selected at the launch of PhytoTrade Africa (SANProTA). Baobab is Africa’s most distinctive and recognisable tree and – functional properties aside – is widely seen as having great marketing image potential.

A rough resource assessment, limited trial purchases and some preliminary processing trials were done on baobab fruits during PIF Phase One. Baobab trees are neither widespread nor common in Namibia (sizeable populations occur only in the western parts of Omusati region and neighbouring parts of Kunene, with smaller populations in Tsumkwe district, Kavango and Caprivi). Zimbabwe, Malawi, Zambia and Mozambique have much larger baobab resources, and are moreover likely to be lower-cost producers than Namibia. Baobab has therefore been described in several PIF 1 reports as a species that would best be commercialised in cooperation with other countries.

2. Recent developments

Since the completion of PIF Phase One the situation around baobab has been impacted by the following developments:

- through participation in European trade fairs PhytoTrade Africa has established that there is a potentially lucrative European niche market for baobab pulp **if it can be certified organic**
- this market is small enough to be supplied from Namibian production for the time being
- in Zimbabwe and Malawi it would be difficult to obtain organic certification because baobab occurs in farming areas where pesticides are widely used
- PhytoTrade has invested a considerable amount of R&D funding in developing commercial opportunities for baobab and there is a good chance that other, larger "industrial raw material" markets for pulp might be developed soon
- additional markets for baobab oil are expected to materialise soon – the French company Bergasol recently launched a sunscreen containing baobab oil

It October 2003 the IPTT therefore agreed to do further work on baobab as a matter of urgency, focussing primarily on pulp production.

3. Work done

3a. Fieldtrip to Omusati

The fieldtrip was done 12-14 November 2003, with the following outcomes:

- a closer assessment of the baobab resource in the Outapi-Tsandi-Onesi triangle confirmed that this area would be the best place to start baobab processing in Namibia, pending the establishment of collation mechanisms for accessing fruit from sparsely populated neighbouring parts of Kunene (where the potential impacts on wildlife would additionally need to be assessed
- the Okahulo Association at Onesi was identified as a community-level partner that can potentially produce organic baobab pulp, because it has already been engaged in the preliminary stages of a pilot project to certify marula and KMS production as organic, is relatively well organised and has limited facilities already available
- November is too late in the season for purchases (according to members of the group August is the best time) and it was only possible to buy 107.5 kg of baobab seed (with adhering pulp) at N$10/kg and 12 kg of whole baobab fruit for processing trials at N$5/kg

3b. Processing at KAP

The aim of this work was:

- to remove the pulp from the baobab seed purchased in Omusati region with a RIIC grain dehuller and record the productivity and efficiency of this process, so as to make available samples and enable more informed business planning
- to extract the pulp from whole fruit cracked at KAP for purposes of comparing its microbial load with that of pulp from fruit cracked by primary suppliers
- to process the left-over (depulped) baobab seed into oil samples

As it turned out the RIIC dehuller (originally designed for sorghum) was completely unsuitable. Some results were available from R&D done for PhytoTrade Africa by SAFIRE in Zimbabwe on a maize dehuller and it was therefore decided to investigate a completely different technology for pulp removal. It was demonstrated that a relatively simple and cheap modification can turn an ordinary hammermill (widely available in northern Namibia) into an efficient baobab pulp processing machine capable of yielding a high quality product.

Since some oil pressing results were already available from PhytoTrade R&D reports, only limited trials with a Mini 50 expeller were conducted, yielding results (3.2% clear oil yield) very similar to those achieved in Zimbabwe (where the average extraction rate of clear oil using the Helius 68 screw press was 3.5%). The oil produced in Namibia was of significantly better quality, but this could be related to the quality of the fruit used.

In Zimbabwe trials with a hydraulic press yielded no oil. At KAP an extraction rate of 8.4% was obtained with the Kapmond30 after some trials, at a daily production of about 1.4 kg per press. This cold-pressed oil was of very high quality.

More details about the pulp processing and oil pressing trials conducted at KAP are contained in Annex A. In both cases the products were of higher quality than those produced in Zimbabwe, but the production rate was lower.

3c. Laboratory screening

Analyses were outsourced to Analytical Laboratory Services in Windhoek. For comparative purposes some fruit from Malawi were included. The results were:

Microbiological assessment	***cfu/g***	***E. coli (MPN)***
Baobab pulp (n = 4)	1300 – 4300	<3
Baobab fruit	<100	<3

(Safe for food use)

Oil quality analyses	***AV***	***PV***
Cold pressed	0.7	1.1
Expeller	1.4	5.3

(Excellent except for expeller PV)

4. Discussion of results

It has been demonstrated that baobab pulp and seed can be processed into high quality powder and oil with equipment that is readily available in Namibia (albeit at lower rates of production than is possible with other technologies). This lowers the initial capital investment required and allows Namibian producers to continue testing niches in the emerging market for baobab products. However, unlike some of her neighbours Namibia does not have a huge baobab resource and it would be premature to make a large investment in baobab processing until the shape of the market becomes clearer. Rapid organic certification remains an important potential competitive edge.

5. Indicative business figures

Whole baobab fruit contains about 50% pulp and seed, which in turn contains some 42% powdered pulp, 53% seed and 5% fibre and other waste. At N$5/kg for whole fruit the raw material price of powder is therefore around N$23.80/kg and of seed around N$18.86/kg without transport cost (when these products are considered separately).

Since pulp and oil are both potentially saleable products, a better way to calculate it that one ton of baobab fruit will yield 500 kg of pulp chunks, consisting of 210 kg pulp powder and 265 kg seed, which in turn will yield 21.5 kg oil (at 8/4% w/w). It will take around 12 days to crack the fruit (can be lowered through technology innovation), about 3 days to extract the pulp by hammermilling, and 15 days to press the oil in a Kapmond30. If the fruits are purchased at Onesi and processed on site (at no rental for the premises), the following scenario can be expected per ton of fruit:

Expected costs (per ton)	
Whole fruit @ N$5/kg	5000
Processing time 30 days @ N$35	1050
Capital depreciation costs N$100/day	3000
Utilities and consumables N$50/day	1500
Management N$150/day	4500
Sub-total costs	*15050*
Income (guesstimated prices)	
210 kg pulp @ N$50/kg	10500
21.5 kg oil @ N$150/kg	3225
2000 shells at N$0.50 ea.	1000
Sub-total income	*14725*
Profit (loss)	**(325)**

This is a near break-even scenario that could be rendered profitable through economies of scale and negotiating higher prices (e.g. through securing organic certification).

6. Recommendations for further work

It is recommended that the IPTT budgets a further N$50 000 for work on baobab starting in August 2004. This should be spent in phases:
a) Trial purchases aimed at securing 2000 kg of whole baobab fruit at N$5/kg
b) Investment in processing if trial purchase is successful and market conditions warrant

If this idea is acceptable in principle a more detailed proposal can be prepared.

ANNEX A

BAOBAB FRUIT:
FURTHER RESEARCH on PROCESSING METHODS

1. Pulp extraction:

This processing stage may be shared into two sequences:

- breaking the fruit's shell to remove its content: fibre and hard chunks of pulp containing the seeds;
- pulp and seeds separation and pulp chunk processing into a fine and clean powder.

1.1. Breaking the fruit's shell to release its content:
Traditionally, the shell is broken either with a stone or a heavy piece of wood (or by hitting the fruit on a hard surface), then the chunks of pulp and seed are collected.

1.2. Pulp and seeds separation:
The most used way in Baobab growing areas consists of pounding the chunks in a mortar in such a way that the seeds are cleared from the pulp without breaking them. However, this method does not allow removing all the pulp from the seeds and does not ensure an even fine pulp powder.

It is also useful to highlight that these traditional methods dealing with manual handling at all the stages are not the best ones if high microbiological quality is required.

2. KAP contribution to Baobab fruit processing:

It must first be acknowledged that most of the material bought from Baobab growing areas was under the form of bags of pulp and seed chunks, meaning that fruits had been manually and traditionally opened in the production areas.
However, we also got some whole fruits.

2.1. Material extraction:

It is worth mentioning that the fruit shell could easily be used as a decorative container for baobab products (or any other craft purpose) if properly opened. Taking this remark into account and targeting the less possible pulp contamination, we used a band saw to cut open the fruits in the middle (half length) removing the material by shaking/hitting or emptying the half shells with a clean table spoon.
Please note that this method can also be used at community level, replacing the band saw by a wood hand saw.
The material was then stored in clean buckets closed by a tight lid.

2.2. Pulp and seed separation:

It was originally planned to use a RIIC dehuller (designed for sorghum grain dehulling); however all the machines available at KAP were equipped with new grinding stones that do not leave enough space between the periphery of the stone and the barrel rubber lining, preventing the seeds to progress in the dehuller and possibly causing damage to the machine (stones broken).
It can also be enhanced that a dehuller is not the panacea for this processing step as pulp should be sifted to discard fibre and possible seed shell debris, and to get a fine powder.

It was then decided to try using a Drotsky S4 hammermill, anyway much cheaper, more versatile (service mill), more widespread in Namibia than dehullers, and easier to operate. This hammermill was equipped with a petrol engine, making easy rotor speed variation.

A lot of trials were made, involving increasing/decreasing rotor speed and material retention time in the milling chamber, as well as sieve's perforation size. We finally achieved a good result with a sieve of 0.8mm at about 800 rpm. The seeds were clean (quite no more trace of pulp on them), a very few were broken and the pulp powder was very fine, pure and fluid, all foreign matter particles (especially fibre) kept in the milling chamber.
Please note that this size of sieve is the most commonly used by service/commercial millers to get the finest and most appreciated mahangu flour in the NCAs.

The front door of the hammermill had to be altered to allow a regular discharge of the seeds from the milling chamber (removing and putting back frequently the front door would have taken a lot of time – 4 wing nuts to be removed and put back each time-).
All the material was processed in batches of 500 to 600g with a feeding rate close to 20 kg per hour.
The average proportion of seeds, pulp and fibre produced was measured (weight) and can be summarized as follow:

- pulp ± 42 %
- seeds ± 53 %
- fibre ± 4 %
- losses ± 1 %

Note:
Despite a relatively low productivity, this processing method requires a minimum of manual handling (possible contamination), generates a high quality pulp powder (no further sifting required) as well as a maximum pulp extraction (seeds hardly whitish when rejected from the milling chamber).

3. Seed processing: kernel and shell separation

Preliminary remark: on the one hand, Baobab seed shell is very hard and represents a significant part of the seed; on the other hand, the kernel oil content is quite low (15 to 20% ?). It was then anticipated that processing only (or mainly) kernels would increase oil production and productivity.

About 80 seeds were manually broken, shells and kernels were separated. Accurate weighing of the two components gave the following figures:

- **kernels: 38.60 %**
- **shells: 61.40 %**

Taking this data into account, it was first attempted to separate, at least partially, shells and kernels.

The same equipment (S4) was tested for this purpose and after a lot of trials involving (again) rotor speed, retention time and sieve perforation size, **an encouraging result was obtained on 18.64 kg of whole seeds with 41.63 % (7.76 kg) of shells and 58.37 % (10.88 kg) of crushed kernels** showing an excess in the percentage of kernels and a corresponding lack in the percentage of shells.

A quick checking confirmed the hypothesis that some (crushed) kernels were mixed with shells and reversely, some shell pieces were mixed with crushed kernels.

In order to improve these results, it was decided to check and measure:

A. The quantity of kernels mixed with the shells: for that purpose, 1 kg of shells was scrutinized and pieces of kernels were manually separated, giving the following breakdown:

- 915g = 91.5%, shells only
- 44g = 4.4%, pieces of kernels
- 37g = 3.7%, mix of small particles of kernels, residual pulp and shells
- 996g identified (99.6%) meaning losses of 0.4%.

From this, we can consider that **the kernel losses may amount to a maximum of 7 to 8%** but that **this loss is probably well compensated by time and money savings at the oil processing stage**.

B. Crushed kernels were put a new time in the hammermill this time with a smaller sieve, allowing to remove part of the broken shells mixed with kernels:

From 10.88 kg of crushed kernels, it was drawn:

- 8.200 kg = 75.37 % of kernel powder
- 2.68 kg = 24.63 % of shell pieces

Then, the adjusted separation figures kernels-shells become:

- **crushed kernels: 58.37 – (24.63 x 58.37 =) 14.37 = 44.00 %** *(theorically 38.60 %)*
- **shells = 41.63 + 14.37 = 56.00 %** *(theorically 61.40 %)*

meaning, from 18.64 kg of whole seeds, 8.20 kg of crushed kernels and 10.44 kg of shells

It is worth noting that the shell-kernel separation allows to make substantial savings as 56 % of the initial material is rejected before oil processing (and has not to be processed).
Furthermore, the broken shells can probably be sold as covering material in nurseries.

4. Oil processing:

4.1. Cold processing:

Trials were made with the fruit press equipped with an oil adaptation and also with a standard 30 ton press.
It was noticed that oil starts flowing under very low pressure and that an excessive or too quick pressure increase leads to the generation of "worms" without oil production.
A significant trial was made with the 8.20 kg of crushed kernels (see **3.B.**) and added water on the 30 ton press.
The material was pressed 4 times giving the following results:

- 1st + 2nd pressings: 388 g of crude oil
- 3rd + 4th pressings: 302 g of crude oil

meaning a total of 690 g of crude oil and an **extraction rate of 8.41 %.**
As the oil was particularly clean and clear, the extraction rate of clean oil would most probably be very close.

Time required for cold pressing: ± 1 hour per pressing (± 4 hours for 4 pressings).

4.2 Processing with the Mini 50 Alvan Blanch expeller:

Several trials were done on the expeller with whole seeds and crushed kernels.

The trials with whole seeds were disappointing as only trace of oil was produced (it is assumed that oil is partially absorbed by the crushed shells and finishes in the cake).

A trial with 3.5 kg of crushed kernels produced 166g of crude oil flowing out of the barrel at around 90ºC. After 48 hours settling, clear oil amounted to about 70%, meaning 112g of clear oil and an extraction rate of about 3.20 %.
The oil quality should be comparatively assessed to cold pressed oil.

5. Conclusion:

5.1. Pulp extraction:

Extraction through a dehuller could not be conducted because of the too small space between the edge of the grinding stones and the lining on the barrel preventing the seeds to progress in the barrel.
The S4 hammermill has proved to be an excellent alternative provided that some adjustments and alterations are done. A few more advantages plead in favour of the hammermill: its price (cheaper than most of the dehullers), its local availability (much

more widespread than dehullers), its operation easiness (much less sophisticated than a dehuller), its low maintenance and running costs, the easiness to grade the pulp with the appropriate sieve…).

5.2 Oil processing (and conditioning):

Kernels and shells separation is one more processing step; however, it has been proved that it is easily feasible to remove 56% of the material (shells) that have no positive role to play in oil extraction.
This is particularly pertinent and interesting if high tech oil extraction is targeted (supercritical CO^2 or ultrasound extraction) as the amount of material to be processed is much smaller or if the kernel material is planned to be used as it is.
Cold processing gives better than expected results in terms of extraction rate even if the process is long.
Cold processed baobab kernel oil is first and best grade oil.