National Agricultural Support Services Programme (NASSP)

Indigenous Green Leafy Vegetables (IGLV) Processing and Marketing Trials

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Disclaimer

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Acronyms and Abbreviations

ARC	Agricultural Research Centre
COSDEC	Community Skills Development Centre
CRIAA SA-DC	Centre for Research Information Action, Southern Africa Development & Consulting
GLV(s)	Green Leafy Vegetable(s)
IGLV(s)	Indigenous Green Leafy Vebetable(s)
ILV(s)	Indigenous Leafy Vegetable(s)
IPTT	Indigenous Plants Task Team
KAP	Katutura Artisans Project
MAWF	Ministry of Agriculture, Water & Forestry
NASSP	National Agricultural Support Services Programme
NAB	Namibian Agronomic Board
NBRI	National Botanical Research Institute
NCAs	Northern Communal Areas
NCRs	North Central Regions (Oshana, Omusati, Ohangwena & Oshikoto)
R&D	Research and Development
SME	Small and Medium Enterprises
TOR	Terms of Reference
Unam	University of Namibia
VIVA	Vigorous Indigenous Vegetables from Africa

Glossary of local terms

Eevanda	dried spinach cakes (plural)
Ekundu	dried cakes made of *Aloe zebrina* flowers
Ekwakwa	*Amaranthus* sp. (mainly *A. thunbergii*)
Iiwhiki	dried cakes made of cowpea leaves and cooking melon
Mahangu	pearl millet (*Penisetum glaucum*)
Mutete/omutete	*Hibiscus sabdariffa*
Omavanda/omahanda	dried spinach cake (singular)
Ombidi	*Cleome gynandra*
Omboga	*Cleome gynandra*
Omundjula	*Sesuvium sesuviodes*

Table of contents

APPENDICES

OVERVIEW AND SUMMARY OF RECOMMENDATIONS

a. This is the final report by CRIAA SA-DC on a consultancy to conduct Indigenous Green Leafy Vegetable (IGLV) Processing and Marketing Trials as part of the Vigorous Indigenous Vegetables from Africa (VIVA) – project. The main conclusions and recommendations from the report are summarised below. For clarification of vernacular names see the Glossary on p iii above.

Conclusions and recommendations about raw material supply and quality

b. If IGLVs are harvested early in the morning and kept cool they will remain in very good condition for at least three days, and will still be marginally marketable after five days.

c. *Cleome gynandra* is the most-preferred species; because of its lower productivity it must be regarded as the top priority for further research into cultivation, and for extension messages to farmers.

d. *Cleome* and *Amaranthus* are traditionally harvested and processed together, usually with a small proportion of *Sesuvium* added. Sticking with the traditional practice of mixing species would be a good idea (backed up by market feedback and agronomic considerations).

e. The functional properties claimed for omundjulu (*Sesuvium*) by traditional processors should be investigated in more systematic detail at various levels of use during future (or possibly separate) trials. If this functionality is confirmed the chemical mechanisms responsible should be investigated by a food science researcher, as they may be of potential value in other food applications.

f. During marketing trials consumer complained that the products contained too many stems. Clear (and preferably visually communicated) quality standards must be agreed with growers/harvesters and strictly enforced, and/or a technological solution must be found (e.g. mechanical leaf stripping or pureeing/creaming during processing).

g. Excessive sandiness was also criticised. In future trials raw materials should be rinsed at least twice (in different waters) and/or a suitable food-grade detergent should be found for use in the first bath to assure that all sand comes loose and settles out, and/or an arrangement for "spinning" the vegetables during washing should be developed and tried.

h. The cost-benefit implications of paying more for better quality versus paying less and spending more on sorting have to be investigated; such anaylses should as far as possible distinguish between different agronomic models (horticulturally produced as monocrop, as a catch-crop, "wild harvested" etc.)

i. Conduct a preliminary investigation into ekundu (*Aloe zebrina* flowers) production and trade.

Conclusions and recommendations about processing

j. Blancing improved the quality of both dried and frozen products. The financial implications of using an industrial microwave oven for blanching should be investigated and weighed up against the higher nutritional losses incurred with water blanching.

k. Recommendation: The manufacture and supply of dried IGLV products should be left to the informal sector for the time being, until/unless strong market signals to the contrary emerge. SME producers should be supported with information on basic food-processing hygiene, and on how to standardise and label their products for more choosy urban markets.

l. Lactic fermentation trials should be continued on a small scale. Because such trials have a relatively low chance of yielding commercially successful products in the short to medium term, but are scientifically interesting (from nutritional, microbiological and food safety perspectives), the collaboration of a suitable post-graduate student would be ideal.

m. Deep freezing should be pursued further as a potentially viable product development and marketing strategy. As a first step a qualified refrigeration engineer should be retained to calculate and cost the refrigeration capacity required. Should the investment appear to be financially viable, existing role players in frozen food distribution in northern Namibia should be engaged in a discussion around the cost and availability of back-load cold chain logistics.

n. Pasteurisation trials should be repeated with thoroughly cooked products filled into plastic bags or waxed cartons while hot and then pasteurised for a longer period at higher temperatures.

o. Continue work aimed at producing a long-lasting ready-to-eat pouched/canned/bottled product that retains the good qualities of fresh IGLVs and appeals to middle to high income consumers. If trials are successful assess shelf life closely and print sell-by date prominently on packaging.

p. Add various (small) quantities of sugar to IGLVs criticised as too sour and re-test to see if this improves their acceptance.

q. The unique characteristics of mutete (*Hibiscus*) must be taken into account when designing future trials – it should not be treated the same as the other species.

Conclusions and recommendations about marketing

r. While there are clear market niches for products with a strong ethnic character and traditional taste, it is probably advisable to anchor future processing in a more "neutral" product that would allow consumers (traditional as well as non-traditional) to prepare it according to their own taste. Concentrate on simple, convenient products and promote their use by publicising attractive recipes in which they can be employed.

s. Issues that are important to urban consumers, such as hygiene, nutritional value, food safety and shelf life, should be recognised and pro-actively addressed by incorporating them positively into marketing strategies.

t. The following market segments can be considered and further investigated:
- Restaurants: more independent and/or African restaurants could be targeted to use especially frozen *Cleome* and *Amaranthus*, and to a lesser extent *Hibiscus*
- Caterers could be targeted to use either blanched/dried or frozen *Cleome* and/or *Amaranthus*
- Soup kitchens and orphanages could be very interested in working with IGLVs, especially blanched/dried or frozen *Cleome* and/or *Amaranthus,* because of their high nutritional value, local availability, familiar taste, and easy storage.
- Middle or higher income urban consumers who are familiar with the traditional vegetables, but are concerned about hygiene, or don't have time to shop at informal markets, or are simply curious to try out a more "modern version", and are willing to pay a higher price for that.
The health food sector, a small but growing sector in Namibia. Consumers in this sector prefer fresh vegetables, but may be convinced to buy frozen, dried, or bottled IGLVs because of the high nutritional value and exotic image.
- A small niche market for dried IGLVs to be use while camping.

u. The initial market research yielded the following useful ideas and suggestions towards a full marketing strategy:
- General promotion of the IGLV should focus on its high nutritional values, through articles, leaflets, and/or clear information on the products.
- Promotion to larger scale consumers, like restaurants, caterers, and soup kitchens, will need a more personal approach, accompanied by handing out samples.
- Promotion to individual consumers may initially require promotion stands in supermarkets and vegetable outlets, where people can taste and smell the products prepared in traditional and non-traditional ways.
- Promotion to urban consumers that are not familiar with the IGLVs should be accompanied by a leaflet with attractive recipes
- Promotion to urban consumers that are familiar with the IGLV should somehow show the superiority of the products compared to the traditionally prepared vegetables in nutritional value, convenience, and/or hygiene.

v. More quantitative market surveys in the different potential market segments should be carried out. This may include larger scale tasting trials at supermarkets or fresh produce stores. The size of the market will largely depend on the price of the various products, and more clarity in this regard is needed

w. Once quantitative data on markets and prices are available, work should be done on designing product image and promotion strategies.

Conclusions and recommendations about laboratory analyses

x. Since no homognised batches of fresh IGLVs were available out of season, the proposed protocol of analysis could not be carried out entirely as planned. NASSP should budget the unspent commitment from this consultancy to carry out the full set

of analyses proposed in the terms of reference, when fresh samples of the target species become available early in the 2006 season.

y. From the analyses that were conducted the consultants wish to point out the following practical implications:
- Omundjulu (*Sesuvium*) is nutritionally vastly inferior in every respect to the three target species – which makes its inclusion (and claims by traditional processors about its functional properties) in spinach mixes that much more interesting.
- Mutete (*Hibiscus*) is somewhat less nutritious than the two other target species; the traditional practice of changing the cooking water (twice) to reduce the sour taste most likely causes large losses of water-soluble nutrients.
- Ombidi/omboga (*Cleome*) is only slightly more nutritious than ekwakwa (*Amaranthus*) but this advantage is offset by ekwakwa's much higher yields (which are in turn counterbalanced by ombidi's preferred taste).
- Vit. C is too easily destroyed to be a reliable indicator of nutrient losses resulting from different processing practices; Vit. A is likely to be more reliable.
- It might be worth considering adding ascorbic acid to processed products (as both preservative and supplement).

Conclusions and recommendations based on price analysis

z. From various price analyses the consultants conclude the following:
- Drying, freezing and bottling of IGLVs are all potentially viable business opportunities, at very realistic units/annum sales levels, provided a smooth flow of raw material can be assured for nine months of the year.
- Even if only 50% of published agronomic yields can be achieved in Namibia, it would take a mere 17ha of cultivated ombidi (and even less if ekwakwa was also included) to supply a potentially viable and sustainable pilot processing plant.
- Such a plant should initially concentrate on producing a neutral “ready-to-eat-bar-the-spicing” product, but should actively investigate the cost implications and distribution logistics of frozen products, and produce smaller quantities of dried products to test niche markets.
- The business should seek from the outset to produce an organically certified, fairly traded product and to access export markets for such products (with help from PhytoTrade Africa)
- The pilot plant will have very little margin for error and it is therefore imperative that it has access to an irrigated supply of *Amaranthus* and *Cleome* (*Hibiscus* can be pursued in parallel at smaller scale). If necessary a “core farm” should be planned.

aa. In conclusion the consultants therefore recommend (in addition to other specific recommendations above) the following way forward:
- That a pilot processing plant be established (by early 2007).
- For reasons of synergy, that the pilot plant be located near Olushande dam in the Omusati Region.
- In preparation for this investment, that a critical mass of contract growers be engaged from among the many horticultural initiatives established around this body of water (preferably, more growers being contracted to grow smaller quantities rather than the other way round), by early 2006.
- That a targeted research/extension effort be implemented during 2006/07, aimed at teaching these contract growers to produce IGLVs commercially, year-round, so that

an uninterrupted supply of raw material is assured before the factory is actually built (starting late in 2006).
- If there is any doubt about the adequacy of the response and uptake from these growers, that a “core farm” be established to ensure adequate raw material supply.
- That the growers and factory be included in the organic certification pilot project currently in planning for Eunda/Onesi/Uukholonkhadi Conservancy.
- That the mass market for dried products be left to traditional processors for the time being, but that smaller niche market be explored further, so as to grow the total demand; to this end, that dried products be included in follow-up nutritional and microbiological analyses.
- That the lessons learned from such a pilot project be correlated with prevailing market realities and – if it seems viable – that the approach be rolled out to other parts of northern Namibia along with organic certification.

MAIN REPORT

1) Introduction

1. This document is the final report by CRIAA SA-DC on a consultancy to conduct Indigenous Green Leafy Vegetable (IGLV) Processing and Marketing Trials as part of the Vigorous Indigenous Vegetables from Africa (VIVA) – project. VIVA is a sub-component of the Indigenous Plant Development Programme currently underway within the wider framework of the National Agricultural Support Services Programme (NASSP), and forms part of a national indigenous plant promotion "pipeline" strategy steered and guided by the Indigenous Plant Task Team (IPTT). The specific Terms of Reference for this IGLV processing and marketing consultancy are contained in Appendix A.

1.1) Processing and marketing trials within the overall VIVA context

2. According to the NASSP *Indigenous Vegetables Development Proposal* the main aim of this particular NASSP component is to have GLVs contribute to enhanced household income for smallholder farmers in the communal areas of northern Namibia – the overall goal of NASSP itself.

3. According to the *VIVA Inception Report* the broader development objective of VIVA is to increase food security and reduce dependence on imported vegetables, and the specific objective is to increase income through cultivation and marketing of indigenous vegetables, which is to be achieved through two key results:
- increased knowledge on indigenous vegetables
- increased use of indigenous vegetables (production and consumptions)

The processing and marketing trials reported here were the first steps taken towards achieving the second key result (increased use).

4. The *Indigenous Vegetables Development Proposal* pointed out that "achieving this aim [enhanced household income] within two years implies a strong focus on product and market development, especially given the low degree of certainty that farmers will actually prioritise more active cultivation of GLVs in the absence of improved markets". The working assumption of this strategy is that an investment in product and market development will lead to financially sustainable processing that will "pull" increased primary production.

5. To develop successful market-driven products it is necessary to engage in an iterative process of identifying clearly defined market niches, developing prototype products, testing consumer response and adapting trial products in line with market feedback. The *Indigenous Vegetables Development Proposal* suggested that potential market niches might be found for fresh produce, improved dried products, and pre-cooked ready-to-serve products (for ease of reference relevant parts of the *Proposal* are reproduced in Appendix B).

6. Cognizant of the constraints that the seasonality of agricultural production imposes on iterative product development and improvement cycles the consultant originally proposed in their tender to NASSP and the IPTT IGLV Sub-group that the processing and marketing work be conducted over two seasons (2005 and 2006).

When this proved problematic due to the cyclic nature of the NASSP funding (which required that the entire budget be spent before end-August 2005) the consultants agreed to a compromise – an initial round of processing and marketing trials at Ondangwa (to coincide with the marula fruit processing work done under separate contract for the IPTT, and thus contain overall expenses), followed by product adaptation and further market investigations in Windhoek.

7. The consultants believed that such a schedule would be tight but workable, provided they could organise production of an out-of-season crop of IGLVs under irrigation for use in the (second, adaptive) processing trials. It is important to note that at this stage the budget had already been agreed and had specifically not included the additional transaction costs of arranging such out-of-season IGLV growing and supply. The (unspoken) assumption from the side of the consultants was that it would, in synergy with the VIVA project coordinator's attempts to promote cultivation, be a relatively simple matter to arrange such contract-growing by one of the project collaborators (using the money budgeted in this consultancy for raw material purchases to pay for the crop). As it turned out, the project coordinator suffered a major health setback which forced him to go to Europe for an operation, and was therefore unable to help as envisaged. While this did not prevent the processing and marketing trials from being carried out, it did have a significant influence on the manner in which they were done, and the results that could be achieved within the available time. The stages of the project at which the project coordinator's enforced absence had a material impact are pointed out below.

2) Raw product intakes and processing trials

8. Only the most important points are highlighted here. For a more detailed account of the work done see Appendix C.

2.1) Equipment and raw material procurement

9. The contract for this work was awarded to CRIAA SA-DC at the end of February 2005 and the first payment was received from NAB on 15 March. By then the lead and main support consultants had already left for Ondangwa to start the marula processing trials. Purchasing of essential processing equipment was somewhat delayed by the Independence long weekend, but was completed on 23 March, allowing a third consultant to travel to Tsumeb that afternoon, where he met with Klaus Fleissner, who had been conducting on-station VIVA cultivation trials at Mannheim ARC.

10. On 24 March the consultant traveled to Mannheim where Mr Fleissner had organised for small samples of three IGLVs – *Cleome*, *Amaranthus* and *Hibiscus* – to be harvested early in the morning while it was still cool. These samples were transported to Ondangwa in a cool box and placed in cold storage (4º Celsius) by 14h00 that afternoon. However, due to the need to offload and set up processing equipment, and the intervening Easter weekend, these samples were not processed or analysed, but used only to monitor the evolution of fresh IGLVs in cold storage. ***Conclusion: If IGLVs are harvested early in the morning and kept cool they will remain in very good condition for at least three days, and will still be marginally marketable after five days.***

11. On 31 March the VIVA project coordinator officially informed stakeholders of his health problems and the fact that he would have to go to Europe for an operation (and would therefore not be available to help with raw material procurement). At that stage all available CRIAA SA-DC consultants were in Ondangwa and busy with marula fruit processing trials. As a "work-around" solution to the supply problem the consultants hastily organised emergency raw material intakes on 6-11 April at a village 7km south of Oluno (with assistance from KAP technician Thomas Ambinga, who comes from this area and was in Ondangwa to help with the marula processing).

12. Although such impromptu community-level intakes were not part of the original plan they helped to overcome the raw material supply emergency and furthermore yielded some useful insights into the practicalities and potential pitfalls of such a supply chain. In total slightly more than 400 kg of four different IGLV species were purchased at an average price of just less than N$9/kg (compared with 200kg at N$25/kg as budgeted). The following observations and conclusions are considered especially pertinent:

a) Ombidi/omboga (*Cleome gynanadra*) was only available in small quantities, because it is the species most preferred by local consumers and the purchases were done relatively late in the growing season. ***Conclusion:*** **Cleome** ***must be regarded as the top priority for further research into cultivation, and for extension messages to farmers.***

b) In the traditional harvesting system people do not target either *Cleome* or *Amaranthus* exclusively, but pick the available material as a mixture.
Recommendation: Sticking with the traditional practice of mixing these two species would be a good idea (also backed up by market feedback and agronomic considerations).

c) Omundjulu (*Sesuvium*) was available in surprisingly large quantities (although there are two types and some respondents later suggested the wrong type may have been supplied). According to information gathered during the market investigations omundjule is never used by itself, but included in *omavanda* (spinach cake) mixtures in small quantities because it improves processing characteristics (shorter cooking time) and texture ("softer" or "smoother"). From this it would seem that omundjulu is not in fact a preferred but scarce species (as the *Indigenous Vegetables Development Proposal* deduced from the information published by the Ombidi Working Group) but a less preferred species used as an "additive" for its specific functional properties.
Recommendation: The functional properties of omundjulu (at various levels of use) should be investigated in more systematic detail during future trials. If possible the chemical mechanisms responsible for this functionality should also be investigated by a food science researcher, as they may be of potential value in other food applications.

d) Paying harvesters by weight alone, without clearly agreed quality standards, creates an incentive to sacrifice quality (selectivity) in favour of quantity (speed/ease of harvest). This is especially true for the extent to which leaves are individually selected, and stems excluded, during harvesting. In retrospect this trade-off is quite obvious: when harvesting for own use people exclude excessive stem material in the

field, to avoid having to do so later, but when harvesting for sale they include stem material, partly to make weight and partly to defer the time cost of selectivity to the downstream processor. Excessive stems in the final products were criticised during consumer trials. ***Recommendation: Clear (and preferably visually communicated) quality standards must be agreed with growers/harvesters and strictly enforced, and/or a technological solution must be found (e.g. mechanical leaf stripping or pureeing/creaming during processing).***

2.2) Post-harvest handling and processing

13. As discussed in more detail in Appendix C, the availability of adequate cold storage facilities is a key consideration in IGLV processing. Given the very high temperatures typical of the production areas in summer, and the mixed nature of the harvest (different species at different stages of ripeness), failure to keep the produce cool before processing would sharply increase the (labour-intensive and expensive) need for hand sorting.

14. Sorting out the raw IGLVs before further processing was a major task (and one for which inadequate provision had been made, since it was assumed that the project coordinator would organise a supply of high-quality raw materials). The need for sorting could be reduced by negotiating with harvesters for better quality in return for a better price. Eliminating (some of) the variability in raw material quality might be easier to achieve under cultivated conditions. The literature on IGLV cultivation indicates that *Cleome* and *Amaranthus* are commonly harvested as ratoon crops, i.e. whole stems are cut off. Considered along with para 12d above this would suggest a closer investigation into the relative merits and cost-benefits of doing the selection of individual leaves at farm level or at the processing plant. For this first round of trials the stainless steel sorting tables from the marula project were used, since the IGLV technology package does not currently include suitable sorting tables.

15. After sorting the IGLVs were washed by pouring them into tubs of water, stirring them, allowing sand to settle out, and then draining them in baskets or colanders (again, the tubs and baskets from the marula project were used for the trials). This approach proved inadequate and during consumer trials excessive sandiness was one of the characteristics widely criticised, especially by non-traditional consumers. ***Recommendation: In future trials raw materials should be rinsed at least twice (in different waters) and/or a suitable food-grade detergent should be found for use in the first bath to assure that all sand comes loose and settles out, and/or an arrangement for "spinning" the vegetables during washing should be developed and tried.***

16. Cutting or chopping the IGLVs did not significantly improve the final products and was a lot of extra work, so it was dropped from the processing sequence. ***Recommendation: Instead of shredding the raw vegetables future trials should rather concentrate on creaming or pureeing the cooked products (in a food blender), especially when they are intended for use in ready-to-use products, to reduce or eliminate the presence of stems.***

17. Water blanching and microwave blanching both improved the texture and appearance of frozen or dried products. Blanching also decreased the drying time

without significantly changing the yield of dried product. Microwave blanching resulted in somewhat lower nutrient losses, but took much longer (4-5 minutes compared to 10-15 seconds) with the small domestic microwave oven used in the trials. ***Recommendation: The financial implications of using an industrial microwave oven for blanching should be investigated and weighed up against the higher nutritional losses incurred with water blanching.***

18. Drying the IGLVs on shade cloth racks in the shade took up to 4 days and resulted in yields ranging from around 10% (*Cleome*) to 15% (*Hibiscus*) to 20% (*Amaranthus*). The initial drying area required is around $1m^2$/2-3kg, but this obviously decreases as the product dries out. The shade cloth rack worked well for raw leaves, but not for blanched material, which should preferably be dried on plastic sheets or fine stainless steel mesh. Although consumer acceptance of dried samples was lukewarm, price analysis suggests that reasonable margins are possible at a price premium of 20% over informal markets, and that even fairly low volumes (90-240 tons wet weight/a) could be financially viable in formal markets, provided such concerns as sandiness and food safety could be addressed. For socio-economic reasons it is however considered ill advised to initiate such processing in competition with the SME sector until an adequate supply of cultivated material is available and the demand has been clarified more precisely. ***Recommendation: The manufacture and supply of dried IGLV products should be left to the informal sector for the time being, until/unless strong market signals to the contrary emerge. SME producers should be supported with information on basic food-processing hygiene, and on how to standardise and label their products for more choosy urban markets.***

19. A prototype solar dryer manufactured for the trials did not have sufficient capacity to constitute a viable business opportunity, even at SME scale, and is most likely too expensive to be attractive for household use.

20. Lactic fermentation of IGLVs yielded samples that were acceptable to some consumers, but the process itself posed significant technical challenges (which have been largely solved at small scale). Curiously enough, fermented mutete (*Hibiscus*) was preferred by panel testers in Outapi because it was not as sour as the other mutete samples. While lactic fermentation is known to increase the nutritional value of many foods, and lightly fermented mahangu is preferred by the majority of consumers, fermenting IGLVs is a fairly radical departure from cultural traditions, making eventual market acceptance unsure. ***Recommendation: Lactic fermentation trials should be continued at small scale. Because such trials have a relatively low chance of yielding commercially successful products in the short to medium term, but are scientifically interesting (from nutritional, microbiological and food safety perspectives), the collaboration of a suitable post-graduate student would be ideal.***

21. Discounted for species likes and dislikes, deep freezing of blanched IGLVs yielded a product that was uniformly appreciated by consumers for its fresh taste and convenience. However, in the conventional domestic deep freezers used in these trials the freezing process was slow (even after pre-chilling in a cold room). Concerns about maintaining an effective cold chain in northern Namibia also cast doubts on the technical feasibility of this preservation method. ***Recommendation: Deep freezing should be pursued further as a potentially viable product development and marketing strategy. As a first step a qualified refrigeration engineer should be***

retained to calculate and cost the refrigeration capacity required. Should the investment appear to be financially viable, existing role players in frozen food distribution in northern Namibia should be engaged in a discussion around the cost and availability of back-load cold chain logistics.

22. IGLVs were blanched, vacuum-sealed in 80 micron plastic bags, and then pasteurised to investigate keeping qualities and food safety aspects of this cheaper alternative to bottling/canning/retort-pouching. Unfortunately the ombidi processed like this was accidentally frozen. Pasteurised ekwakwa seemed fine after several weeks of room temperature storage, but microbiological analysis found more than 50 million colony forming units (cfu) of gram positive cocci bacteria in the sample after three months (the acceptable level for ready-to-eat foods is ten thousand cfu). While it might be possible to improve the shelf life of a pasteurised product by keeping it in refrigerated storage it is likely that such a product would need to be consumed within two weeks, which does not really aid out-of-season marketing much and adds a complex and expensive stock-turn aspects to managing quality. ***Recommendation: Pasteurisation trials should be repeated with thoroughly cooked products filled into plastic bags or waxed cartons while hot and then pasteurised for a longer period at higher temperatures.***

23. The planned retort-pouching trials could not be carried out because the only South African supplier of such pouches reneged on its undertaking to make available 10 000 run-on bags as samples (minimum batch size is usually 100 000) and no alternative supplier could be identified in time. However, a very similar product line – various recipes of cooked IGLVs sterilised in glass bottles – proved popular with consumers at all levels, despite some reservations about food safety and expiry dates. One bottle went off, and in a few others a white deposit formed on the surface of the contents (this was later identified as harmless precipitations of a carbonate salt). ***Recommendation: Continue work aimed at producing a long-lasting ready-to-eat product that retains the good qualities of fresh IGLVs and appeals to middle to high income consumers. If trials are successful assess shelf life closely and print sell-by date prominently on packaging.***

3) Market research

24. The most important activities and findings of the market and consumer research activities are highlighted below. For more details see Appendix D.

3.1) First panel test – Outapi market

25. A panel of 15 people was convened at Outapi market on 13 July, including three market women who prepared the samples in the traditional way and gave valuable "key informant" feedback. The composition of the panel was as follows:

IGLV panel test Outapi market

Particulars of respondents

	R/U/F	Gender	Age	Ethnicity	Occupation
R1	rural	F	23	Ombalantu	market woman
R2	rural	F	42	Okwambi	market woman
R3	rural	F	18	Ombalantu	market woman
R4	rural	M	25	Ombalantu	tailor
R5	rural	F	32	Ombalantu	market woman
U1	urban	M	47	Ombalantu	town clerk
U2	urban	F	32	Ombalantu	market woman
U3	urban	F	30	Ombalantu	town planner
U4	urban	F	34	Ombalantu	market woman
U5	urban	M	20	Uukwaluudhi	tailor
F1	foreigner	F	24	Swiss	volunteer
F2	foreigner	F	27	Finnish	volunteer
F3	foreigner	F	26	Finnish	volunteer
F4	foreigner	F	33	Sri Lanka	volunteer
F5	foreigner	M	39	Sri Lanka	program officer

26. The strongest conclusion that can be reached from the result of this first panel tasting is that the way in which preserved IGLVs are subsequently prepared for the table has an important influence on how they are perceived by various classes of consumers. All the samples were prepared in the traditional Owambo way – cooking for a long time and adding lots of oil – which resulted in all of them scoring quite low with foreign panelists. When non-traditional consumers were later allowed to prepare the products in any way they liked, the results were much more positive. Conversely, a sample of traditional spinach cakes (about which more below) scored tops with traditional consumers. ***Conclusion: While there are clear market niches for products with a strong ethnic character and traditional taste, it is probably advisable to anchor future processing in a more "neutral" product that would allow consumers (traditional as well as non-traditional) to prepare it according to their own taste.***

27. The product most strongly preferred by the panel was traditional eevanda (spinach cakes) made with a mixture of ombidi (*Cleome,* also known as omboga in this part of the NCRs), ekwakwa (*Amaranthus*) and another IGLV (which did not form part of these trials but is popular in the Outapi area), ekundu (flowers of *Aloe*

zebrina). Since aloe flowers are generally appreciated for their sweetish taste, and since many panelists criticised various (especially *Cleome* and *Hibiscus*) products as "too sour", one is left wondering whether this is not a case of – as most junk food manufacturers know – the proverbial spoonful of sugar helping the medicine go down. ***Recommendation: Add various (small) quantities of sugar to IGLVs criticised as too sour and re-test to see if this improves their acceptance. Further recommendation: Conduct a preliminary investigation into ekundu production and trade.***

28. The conclusion that final preparation for the table is more important than preservation method is underscored by the fact that a different preservation method received top score in each vegetable category (ombidi = blanched and shade dried; ekwakwa = jar sterilised; mutete = lacto-fermented; mix = boiled and sun dried).

29. Even in this traditional informal market, where dried products are the out-of-season default, the cooks uniformly preferred the bottled or frozen products because they were quicker and easier to prepare and used less water. One can speculate that such convenience would be even more valuable to employed urban consumers with less available time (as apparently confirmed by follow-up trials in Windhoek.)

30. Analysis of the comments made by panelists and cooks yields the following key concepts for product development:
- Positives: soft, smooth, fresh, green colour, nice smell, easy preparation
- Negatives: branchy/coarse, sandy, sour, bitter, strong after-taste, black colour

31. The very low ratings (including one "My God!) that mutete received from the panel at Outapi should be discounted for the fact that the cooks were unfamiliar with this vegetable (which is mainly consumed in Kavango) and did not change the cooking water to reduce the sour taste. It is also possible that the particular strains of *Hibiscus* used were either from a different species (not *H. sabdariffa*) or had not been selected for a milder taste (which has happened in West Africa and – maybe – in Kavango). ***Recommendation: In future trials the unique characteristics of mutete must be taken into account when designing the trials – equal treatment is not always equitable (or scientific, for that matter).***

32. An interesting observation that emerges from the questionnaires completed by the traditional consumer on the Outapi panel is that all of them eat pure ekundu, pure ekwakwa, and ombidi/omboga mixed with ekwakwa and/or omundjulu, but only six of them eat pure ombidi/omboga (the other three claiming that it is too sour). In Windhoek a professional restaurateur from West Africa considered the two species quite similar. When this preference and/or substitutability is seen against agronomic considerations – specifically that *Amaranthus* is much more productive than *Cleome* – it would appear to support the suggestion in the *Indigenous Vegetables Development Proposal* that the "best compromise" between productivity and consumer preference is likely to be a mixture that is mainly ekwakwa, with just enough ombidi to impart a flavour acceptable to the majority of consumers.

3.2) Further cooking and tasting trials - Windhoek

33. Reflecting on the Outapi panel tasting and interviews, and the critical role that preparation had played, the consultants concluded that employing a less structured, more qualitative and more "innovation friendly" approach in the second round of consumer trials would yield more usable information. Seven individuals and one group of cooks (selected so as to reflect a wide variety of cultural, socio-economic and culinary backgrounds, as well as key potential market sectors) were therefore supplied with a selection of the available IGLV products, encouraged to experiment with recipes they liked, and asked open-ended questions about their observations and likely purchasing choices. Details are contained in Appendix D.

34. One striking result from the Windhoek trials was how strongly frozen IGLVs suddenly came to the fore, compared with Outapi. All the catering professionals involved and most of the other participants (even those who do not own freezers and would therefore not normally buy frozen foods) preferred the taste and convenience. Nevertheless, dried and bottled products also had support.

35. The wide variety of recipes (and serving approaches) employed by the Windhoek participants underscores the wisdom of initially concentrating on "neutral" products that can be prepared in a variety of ways. ***Recommendation: Concentrate on simple, convenient products and promote their use by publicising attractive recipes in which they can be employed.***

36. Not surprisingly the Windhoek participants confirmed that urban consumers are more concerned about issues like hygiene, nutritional value, food safety and shelf life. ***Recommendation: Recognise these as valid issues that are important to consumers, address them pro-actively and incorporate them positively when developing marketing strategies.***

4) Nutritional and microbiological analyses

37. Raw samples of the four IGLV species purchased were flown from Ondangwa to Windhoek (on ice) and analysed. Six processed (frozen) samples of *Cleome*, *Amaranthus* and *Hibiscus* were analysed later, partly to compare nutrient losses between water blanched and microwaved samples. One pasteurised sample of *Amaranthus* was analysed for microbiological safety. For details see Appendix E.

38. The original protocol of analysis proposed in the terms of reference (Appendix A) was designed to contain laboratory costs by conducting full comparative nutritional analyses only after selection of three preferred processing methods, at which stage it was proposed to analyse five samples (fresh, traditionally processed, and processed by the three preferred methods) from one homogenised batch of each of the three target species. This was not done for two reasons:
- the health-enforced absence of the VIVA project coordinator (and the knock-on effect this had on the consultants' assumptions about organising contract-growing of an out-of-season crop of IGLVs, as explained in para 7 above) meant that homogenised batches of fresh vegetables were not available when needed (and since there was no baseline for nutrient losses from freezing IGLVs it was considered unreliable to use the frozen samples)

- the consultants could not be sure of receiving tax receipts and other documents required for accounting purposes in good time (because key analyses such as Vit A had to be sub-contracted to South African laboratories)
Recommendation: NASSP should budget the unspent commitments from this consultancy to carry out the proposed analysis protocol – including Vit A - early in the 2006 season when fresh samples of the target species become available.

39. Nevertheless, from the analyses that were conducted (Appendix E) the consultants wish to point out the following practical implications:
- Omundjulu (*Sesuvium*) is nutritionally vastly inferior in every respect to the three target species – which makes its inclusion (and claims by traditional processors about its functional properties) in spinach mixes that much more interesting
- Mutete (*Hibiscus*) is somewhat less nutritious than the two other target species (the anomalously high Vit. C content of the processed mutete samples is thought to be an analytical hitch); the traditional practice of changing the cooking water (twice) to reduce the sour taste most likely causes large losses of water-soluble nutrients
- Ombidi/omboga (*Cleome*) is only slightly more nutritious than ekwakwa (*Amaranthus*) but this advantage is offset by ekwakwa's much higher yields (which are in turn counterbalanced by ombidi's preferred taste). ***Conclusion:*** **Cleome** ***and*** **Amaranthus** ***are similar and complementary enough to be developed in tandem.***
- Vit C is too easily destroyed to be a reliable indicator of nutrient losses resulting from different processing practices
- It might be worth considering adding ascorbic acid to processed products (as both preservative and supplement)

40. Namibia would benefit greatly from increased capacity (especially in the private sector) to conduct more comprehensive and complex nutritional and bio-chemical analyses (e.g. characterisation of phenolic compounds in *Cleome*).

5) Price analyses

41. The price of N$9-10/kg paid for the raw IGLVs used in these trials should be recognised for the arbitrary emergency response it was, and – despite the fact that it was a willing-seller-willing-buyer price considerably lower than the N$25/kg projected by the VIVA project coordinator – should not under any circumstances be regarded as price-setting of any kind. The prices and calculations below suggest that a farm-gate price nearer N$2/kg be targeted. Additional agronomic and agro-economic data from the cultivation trials should be analysed to determine whether this price would make growing IGLVs viable for producers and competitive with alternative crops. In doing these calculations it would be important to bear in mind that IGLVs grow very quickly and are therefore potential low-input catch-crops.

42. The highest price encountered for a dried IGLV product in an informal market was almost N$100/kg (N$98/kg for ekundu in Katutura, almost matched by N$97/kg for eevanda spinach cakes). Assuming a dry-weight yield of 10-15% (and discounting processing and marketing costs completely, on the assumption that surplus family labour with zero opportunity cost is used) this translates into a raw material price ranging from less than N$7/kg to almost N$10/kg.

43. At the lowest price encountered in informal markets (N$28/kg), and on the same assumptions as above, the equivalent raw material price would be N$2.80 to N$4.20/kg.

44. The median price across all samples in all markets was N$53.70/kg – implying an equivalent raw material price of N$5.37 to N$8.06/kg.

45. An exercise to roughly estimate a financially viable scale for a formal-sector dried IGLV business: assume that a quality dried product for formal markets can retail at N$120/kg before it encounters serious price resistance. At 50% retail mark-up the product can therefore wholesale for N$80/kg. At a (high) primary producer price of N$5/kg wet weight, and a 10% clean dry weight yield, the margin is N$30/kg dry weight. If the primary producer price is dropped to N$2/kg (more in line with conventional horticultural crops), the potential margin is N$60/kg dry weight. Against this margin must be offset the following estimated variable costs per kilogram of dried product:

- Transport to factory @ 0.25/kg (wet)	2.50
- Vacuum bag and label @ 0.75/100g	7.50
- Marketing and distribution	8.00
Sub-total	*18.00/kg (=1.80/kg wet weight)*

Assume further that the processing facility works nine months of the year but pays staff for 13 months, so that annual fixed costs are more or less as follows:

- Capital costs (25%/a on N$200 000)	50 000
- Management (7 000 x 13 months)	91 000
- Staff (6 x 1500 x 13)	117 000
- Water and electricity (2000 x 9)	18 000
- Miscellaneous (1000 x 9)	9 000
Sub-total	*285 000*

At N$5/kg primary producer price (N$12/kg dry product gross margin) the break-even point would lie somewhere around 23.75 tons dry weight per annum (~240 tons wet product/a, 240 000 units); at N$2/kg for raw material (and N$32/kg gross margin for dry product) it could be as low as 8.9 tons/a, or about 90 000 units sold (which would require processing about 90 tons of wet material).

46. To process 90t in 9 months means processing about 500kg/day. Since blanched IGLVs require less drying space (say 5kg/m^2), and dry to acceptably low moisture levels in about 4 days (plus 1 day for cleaning and turn around) around 500m^2 of drying racks would be required.

47. For comparison, freezing preserves 100% of the wet weight. If the product is packed in 500g bags the variable costs/kg (over and above raw material) are:

- Transport to factory	0.25
- Vacuum bag and label (0.75 x 2)	1.50
- Marketing and distribution	10.00 (frozen transport/storage)
Sub-total	*11.75/kg*

Even at N$2/kg primary producer price such a frozen product will not be able to meet the price expectation of N$5/500g packet expressed by participant MK during the Windhoek market study. At participant EK's indicated price ceiling of N$12/500g (N$24/kg, which at 50% retail mark-up is equivalent to N$16/kg wholesale) and at N$2/kg primary producer price, the product will clear a gross margin of N$2.25/kg

wet weight. Assuming capital costs were about equal, break-even could therefore be achieved on a volume of around 127t/a (or 155 000 units). While this is somewhat higher than the best-case scenario for dried product (which additionally carries lower risks of accidental spoilage), the frozen product has the advantage of targeting a market segment where it is not competing with SME processors at all.

48. A bottled/canned/retort-pouched product could fetch N$12-15/unit, according to market-study participant JC. At the midway price point (N$13.50, which is quite high but achievable for such a product) and assuming 400g packs, this is N$20.25/kg wet weight (nett of 50% retail mark-up.) With pouches (bottles and cans will be much more expensive) the variable costs/kg will be:

- Transport to factory	0.25
- Pouch bag and label (0.75 x 2.5)	1.88
- Marketing and distribution	8.00
Sub-total	*10.13/kg*

At N$2/kg to primary producers the margin is N$8.12/kg and break-even can be achieved off about 35 tons/a (87 500 units) if capital costs are the same (which they will probably not be, given that this is a more sophisticated technology). Although this option would most likely require a substantially larger initial capital investment, it does open up export opportunities, which the alternatives don't (or at least not to the same extent).

49. At least two types of export niche markets can be identified from previous (unsolicited) enquiries received by CRIAA SA-DC:
- An African diaspora market for an “ethnic” product (in this case in the US, which entails onerous non-tariff barriers to overcome) – this market is significantly politicised and would presumably attach a premium to fair trade claims.
- An international LOHAS (“lifestyles of health and sustainability”) market comprising consumers who are concerned about the impacts of their consumption patterns on their own health and on the global environment. To break into this market with an IGLV product from Namibia would require a judicious blend of organic certification, fair trade, pro-poor and (paleo-)nutritional claims, wrapped in an “unspoilt traditional Africa” image and marketed in partnership with a strong commercial partner that has access to appropriate distribution logistics and networks. From recent observations in the UK retail market it is estimated that a certified organic, fairly traded export product could fetch double the projected domestic price, or more, if marketed correctly.To increase the chances of success in export markets it is advisable to link the further commercialisation of IGLVs to national efforts aimed at various forms of certification and brand-building. Creating a demand for certified IGLVs would enhance the functioning of smallholder groups, make the Internal Control Systems more robust, and increase the overall rewards for participating in the certification exercise.

6) Conclusions and way forward

50. From the above the consultants conclude the following:
- Drying, freezing and bottling of IGLVs are all potentially viable business opportunities, at very realistic units/annum sales levels, provided a smooth flow of raw material can be assured for nine months of the year
- Even if only 50% of published agronomic yields can be achieved in Namibia, it

would take a mere 17ha of cultivated ombidi (and even less if ekwakwa was also included) to supply a potentially viable and sustainable pilot processing plant
- Such a plant should initially concentrate on producing a neutral "ready-to-eat-bar-the-spicing" product, but should actively investigate the cost implications and distribution logistics of frozen products, and produce smaller quantities of dried products to test niche markets
- The business should seek from the outset to produce an organically certified, fairly traded product and to access export markets for such products (with help from PhytoTrade Africa)
- The pilot plant will have very little margin for error and it is therefore imperative that it has access to an irrigated supply of *Amaranthus* and *Cleome* (*Hibiscus* can be pursued in parallel at smaller scale); if necessary a "core farm" should be planned.

51. In conclusion the consultants therefore recommend (in addition to other specific recommendations above):
- That a pilot processing plant be established (by early 2007)
- For reasons of synergy, that the pilot plant be located near Olushande dam in the Omusati Region
- In preparation for this investment, that a critical mass of contract growers be engaged from among the many horticultural initiatives established around this body of water (preferably, more growers being contracted to grow smaller quantities rather than the other way round), by early 2006
- That a targeted research/extension effort be implemented during 2006/07, aimed at teaching these contract growers to produce IGLVs commercially, year-round, so that an uninterrupted supply of raw material is assured before the factory is actually built (starting late in 2006)
- If there is any doubt about the adequcy of the response and uptake from these growers, that a "core farm" be established to ensure adequate raw material supply
- That the growers and factory be included in the organic certification pilot project currently in planning for Eunda/Onesi/Uukholonkhadi Conservancy
- That the mass market for dried products be left to traditional processors for the time being, but that smaller niche market be explored further, so as to grow the total demand; to this end, that NASSP use the unspent commitments from this project to pay for nutritional and microbiological analyses that include dried products
- That the lessons learned from such a pilot project be correlated with prevailing market realities and – if it seems viable – that the approach be rolled out to other parts of northern Namibia along with organic certification.

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APPENDIX A: **Terms of Reference**

CONSULTANCY PROPOSAL
Indigenous Green Leafy Vegetables Processing Trials

CRIAA SA-DC

Background of the consultant

CRIAA SA-DC (Centre for Research Information Action in Africa – Southern Africa Development and Consulting) is a Namibian-registered association-not-for-gain whose work around processing indigenous resources is well known in Namibia and the region. An organisational profile is attached.

As it lead consultant for this work CRIAA SA-DC proposes to use Roger Gamond, a technologist with many years of experience in developing new appropriate technologies for food (e.g. mahangu, fruit, oil) processing (CV attached). Mr Gamond will be assisted in the design, record-keeping and statistical analysis of trials by Julien Gallardo, a volunteer from France with IT and statistics skills (CV attached). Other CRIAA SA-DC members (including Pierre du Plessis, who designed the original VIVA proposal, and Saskia den Adel, who has experience of market and consumer surveys, especially in rural areas) will provide technical and management backstopping to the project as required. Scientific services will be sourced from Silke Rugheimer (who has a Masters degree in micro-biology) of Analytical Laboratory Services, a well-known commercial laboratory in Windhoek (see quotations attached).

Proposed methodology

Overview
IGLVs are of interest to rural development because they need low levels of purchased inputs, are fast growing and have high yields. Much work has been done in other parts of Africa on improved cultivation practices, but in Namibia most IGLVs are only harvested during the rainy season (cultivation trials are therefore included in other parts of VIVA). The work proposed here will attempt to deliver two sets of outcomes:
a) An assessment of methods that would allow fresh IGLVs to be marketed for longer periods, and/or in formal retail markets. The main considerations will be cleaning and (cold) storage.
b) Preservation methods that would allow year-round marketing. The main considerations will be cost of technology, cost of production, consumer acceptance and shelf-life.

Processing trials proposed
A schematic representation of potential processing trials is included in the table below.
Cleome, *Amaranthus* and *Hibiscus* provided by the VIVA Coordinator and/or purchased by CRIAA SA-DC will be used for these trials.

N°	Collection	Washing	Draining	Chopping	Blanching	Micro-waving	Drying	Lactic fermentation	Deep freezing	Packing	Vacuum pack	Pasteuriz.	Sterilization	Retort pouch	Fridge	Deep freeze	Room temp	Est shelf life
Conditioning							*Processing before packaging*			*Packaging*	*Processing after packaging*				*Storage*			
1	x	+	+	x			x			Alum.pouch or plastic bag	+				x x			12+
2	x	+	+	x				x		Processing container							x	2
3	x	+	+	x				x		Glass jar		x					x	6
4	x	+	+	x	x		x			Alum.pouch or plastic bag	+				x x			12+
5*	x	+	+	x	x				x	Plastic bag	+					x		3
6	x	+	+	x		x				Plastic bag						x		3
7	x	+	+	x	x					Glass jar		x					x	6
8	x	+	+	x	x					Glass jar			x				x	12 +
9	x	+	+	x	x					Special pouch				x			x	12+

x – compulsory
+ - optional
* Indicated shelf life of a similar product (uncooked spinach) packed in plastic bags and kept deep frozen: 3 months at -18°C; 1 month at -12°C; 1 week at - 6°C
As the table above shows, four different types of processing will be used in various combinations to trial nine distinct processing flows:

- Heat treatment: Canning (in bottles, with cost estimates for using tin cans), blanching/steaming, batch pasteurisation, and micro-waving. Retort pouching will be tried provided samples of pouches can be obtained in small quantities (no more than 10 000). The only known supplier in South Africa usually sells minimum batches of 100 000 but has indicated that it will try to assist by doing a run-on of another order. Bottled GLVs will not be very different (organoleptically) from a pouched product and can be used for tasting trials if pouches are not available. Should this happen a rough costing exercise will be done to determine if a larger retort pouching trial will be justified in future. Micro-waving is proposed as an alternative solution to blanching or steaming at the conditioning stage. However, it can also be tried as a preservation method for pasteurization, sterilization and possibly even pouching.
- Drying: Electric, solar, shade, sun (Vitamin C used as indicator nutrient). Drying with or without blanching is one of the simplest preservation methods; nutritional analysis will determine the best method; recommendations for improving and standardising traditional drying methods will be formulated.

- Controlled environment: Deep freezing (preservation), refrigerated storage
- Lactic fermentation is also a very simple method; for people used to eating fermented mahangu meal, the slightly acidic taste should be acceptable and even welcome.

Provided each of the three targeted IGLV species is available in sufficient quantities, a total of at least 27 basic trials will be done. If the four different drying methods are factored into the calculation the total number of trials could rise to 36. Input from focus groups and market investigations will then be used to narrow the range of products down to the three best candidates (which will be subjected to more detailed laboratory analyses as detailed below).

The expected shelf life in the far right column of the table is only indicative and should be confirmed by these trials: for dried and frozen material, the shelf life is likely to be mostly determined by the loss of original organoleptic properties, especially flavour; for pasteurized, sterilized and fermented material, micro-biological tests will determine the shelf life.

An economic comparison of processing methods will be done. The final report will include advice on packaging, promotion and price. Pre-treatment and post harvest practices to prolong the shelf life of the vegetables and to improve the taste, appearance and convenience will also be recommended.

Analyses

There is no laboratory in Namibia that can do full nutritional analyses reliably and cost-effectively. To complicate matters further, the IGLVs that will be used in these trials are wild-gathered (i.e. genetically heterogeneous and harvested from various plots with different but unknown levels of fertility). The approach to nutritional analysis that is proposed here is designed to work around these constraints in a way that will yield useable results.

As far as nutritional losses resulting from processing are concerned, it is respectfully submitted that ANY process which does not expose the material to prolonged boiling and sun-drying (the main traditional preservation method employed in Namibia) would be superior, and that the real and more urgent need would therefore be to analyse the products for general food safety, possible microbiological contamination, and shelf-life. Since Vitamin C is water-soluble and also degraded by heat or light it is regarded as a suitable indicator nutrient to use for a rough comparison of nutrient losses during processing trials.

Once consumer testing has been done and three preferred methods have been selected, comparative nutritional analyses will be done using one homogenised batch of vegetables (fresh, traditionally processed, processed with 3 improved methods, i.e. five analyses in total). Results will be compared with values indicated in the literature

Food safety/microbiology analyses will be done on all products that are to be submitted to focus groups or taste panels, and as required to test shelf life.

Market research
Samples of products developed during the processing trials will be used for tasting, consumer preference and product acceptance trials with traditional and new consumers, working in focus groups and through in-depth interviews. Two panels of around 15 women each will be convened in the NCRs and Windhoek respectively (because women make most household food purchase decisions).

The first panel will be convened in the NCRs and will include traditional producers/consumers (for their potentially valuable insights into product qualities and the behaviour of current markets), recently urbanised consumers (who are potentially a prime market for the new products) and some people who do not usually eat IGLVs (to assess opportunities in non-traditional markets).

The second panel will be convened in Windhoek and will comprise representatives from three potential market segments – ABC-income traditional consumers (who might prefer a more expensive but more convenient product), low-to-medium income working mothers from traditional consumer groups (who might prefer a cheaper product that can boost family nutrition in a slightly less convenient way), and a few panellists from groups who do not traditionally use IGLVs (but who might nevertheless use the new products because they are available, convenient and nutritionally superior to conventional vegetables).

In addition to these two consumer panels, basic price analyses will be done in the NCRs and Windhoek. Test marketing of preferred samples will be done through existing informal-market outlets (the only existing market channel) and 30 semi-structured interviews with most likely potential consumers (e.g. urbanised traditional users, head chefs from hotels/restaurants) to get their reaction and feedback.

In analysing the results of the market investigations, hypotheses about markets and their behaviour will be presented, background information, such as information about actual consumer product usage situations, will be highlighted, and an attempt will be made to understand the motivations, contexts and conditions behind product usage in more accurate detail. The cultural dimension of product usage including information about ethnic, regional and demographic differences will be explored.

Outcome and results

The outcome of the work proposed will be to give answers to the following questions:

- Which product should pass which process
- What volume
- Which technique / equipment to use
- Is it safe for human consumption
- What is the nutrient retention in preferred products
- How to organize future processing activities
- What are the cost/benefit estimates
- How should the business/market plan be structured

Two technical reports on the processing trials (progress report in May 2005 and final report in August 2005) in form of a process flow diagram, indicating the problems encountered and solutions proposed

Two market reports (inception report in May 2005 and final report in August 2005) including marketing strategy recommendations based upon the study findings. The two reports will allow analyses of the validity and reliability of the research findings, create hypotheses about market place behaviour, and make recommendations for further precisions via more quantitative surveys (to learn about the overall size and segmentation of the market).

Timeframe

Preparatory work can start on 1 March 2005. The first processing trials and the first market investigations will be completed by May 2005. The consultants will work closely with the VIVA Coordinator in an attempt to ensure that sufficient raw material is produced (under irrigation if necessary) to allow larger-scale production of samples of preferred products in May/June 2005, and completion of all the work by end-August 2005.

Budget

Nº	Quantity	Description	N$/unit VAT Incl.	Total N$ VAT Incl.
Equipment				
1	1	Stand with 2 gas burners	1,410.00	1,410.00
2	own	9 kg gas bottle and regulator	300.00	
3	1	Processing table, stainless steel	1,700.00	1,700.00
4	own	Microwave oven, 20 L mini, with lids	1,500.00	
5	1	11L Alum. pressure cooker	600.00	600.00
6	1	Pressure gauge for above	400.00	400.00
7[1]	2	270L deep freezer/chillers	2,095.00	4,190.00
8	own	electric dehydrator	2,000.00	
9	1	Convection sun drier (to be made)	8,500.00	8,500.00
10	own	Food processor (chopping blades)	750.00	
11	1	Domestic vacuum sealer	300.00	300.00
12	own	5 kg electronic scale	2,500.00	
13	2	Shallow 20 L aluminium pots	720.00	1,440.00
14	2	Metal baskets fitting inside above pots	120.00	240.00
15	own(3)	20 l plastic buckets	60.00	
16	own(3)	30L shallow plastic basins	60.00	
17	2	Large (60x cm) stainless strainers	230.00	460.00
18	2	large salad spinners	100.00	200.00
19	2	60 x 45 cm plastic chopping boards	100.00	200.00
20	2	45 x 35 cm stainless steel trays	70.00	140.00
21	2	0-200ºC alcohol thermometers	50.00	100.00
22	1	small box of pH strips	150.00	150.00
23	1	Box of 100 plastic disposable gloves	40.00	40.00
24	30	300ml glass jars	5.00	150.00
25	1	50µ thick plastic bags (3 sizesx1000)	500.00	500.00
26	1	80µ thick 150x250 vacuum bags (1000)	400.00	400.00
27	2	large (large mouth) jars + lids (ferment)	100.00	200.00
28	own	Cutlery and miscellaneous	200.00	
29	1	Cleaning materials and products	300.00	300.00
30	3	Small cool box for samples transport	200.00	600.00
31[2]	10	Retort pouches (120+70 x 325 mm; 12 mic PET/9 mic foil/75 mic CPP) (1000/batch)	428.50	4,285.00
		Sub-total (equipment)		***26,505.00***
Other expenses				
32[3]	200	Raw material (kg)	25.00	5,000.00
33	3	Airfreight samples Ondangwa-Eros	350.00	1,050.00
34	10	Per diems	500.00	5,000.00
35	5,000	Project transport (km)	3.50	17,500.00
36[4]	Lump	Analyses	Lump	35,195.00
37[5]	39	Consultant days	2300	89,700.00
		Sub-total (other expenses)		***153,445.00***
		TOTAL		**179,950.00**

Budget notes:

1) One for freezing, one for chilling
2) Pouches from Cape Town cost N$428.50/1000 in minimum batches of 100,000. Company might be able to provide 10,000 samples for trials.
3) To be supplemented with produce from rest of VIVA project; refundable at cost (incl. transport cost)
4) Based on five complete analyses as per attached quote from Analytical Laboratory Services, plus selected analyses of products during initial processing trials; refundable at cost
5) Includes project coordination and accounting, administrative support and office expenses

APPENDIX B

Discussion of potential IGLV product and market niches

[Extracted from *Indigenous Vegtables Development Proposal*, NASSP Report No.005/2004]

63. GLVs are currently sold in informal markets in the form of dried cakes (*omavanda*) at all times, and are usually also available as loose dried spinach, sold by the cup. During times of abundance fresh and cooked spinaches are also sold by the cup. The cooked and/or dried products are usually mixtures of various species, prepared according to individual taste (and availability). *Cleome* (*ombidi*) is the main species sold fresh (recent reports suggest that some farmers are now cultivating it under irrigation to supply out of season).

64. Prices are known to fluctuate seasonally, especially for fresh and freshly cooked products – prices are high in the early season when the plants are still scarce, drop lower when the produce becomes more abundant, and are at their lowest late in the season (by which time most people are tired of spinach and many are only harvesting for processing and storage) (Nekwiyu 1996). The *omavanda* price is less volatile, but the demand for this product (which is widely consumed but reportedly not hugely popular) is very low during the months when fresh GLVs are readily available, and during the harvest months (because milk and other spinach substitute are plentiful at that time).

65. Price gradients are known to exist between informal markets in the NCAs and those in the main urban areas, but these have not been quantified. In general there is a lack of data on the quantities of GLVs traded in informal markets, on market mechanisms used to access these markets, and on prices in various markets in different seasons (and in different stages of any particular season).

66. Despite the lack of data it is clear from personal observations and comments made by key informants that the informal GLV trade is central to the livelihood strategies of some households, and additionally provides an important source of affordable protein for poorer people in urban areas. Until the informal trade is better understood, it is recommended that no actions be taken that could negatively affect the current system, either by reducing the access poorer people now enjoy to “wild” spinach harvested from the fields of their neighbours (which is possible because the major constraint on production is labour availability during the rainy season), or by increasing prices in informal markets (which could result from stimulating demand without paying sufficient attention to measures aimed at increasing production).

67. Nekwiyu (1996) calculated that an average household in the NCRs already consumes fresh or dried wild spinach as part of 159 meals a year. Kakujaha-Matundu (1996, quoted in Kolberg 1999) recorded from the Okakarara area that wild spinach was consumed three times per week by the household studied. It is therefore far from certain that there is in fact an under-supplied demand for spinach in its traditional production areas.

68. What is clear, however, is that the vast majority of consumers prefer young, freshly cooked spinach over the older or dried product. This suggests two potential

niche market products: young (i.e. acceptably mild and succulent) GLVs marketed as fresh produce, and ready-to-serve "freshly cooked" spinach preserved by canning (or some other appropriate technology). Both products would primarily be aimed at recently urbanized traditional consumers with increased disposable incomes; the ready-to-serve product would additionally meet the growing demand for convenience foods.

69. When these two options are compared it is worth noting that *Cleome* reportedly loses its characteristic flavour (a major consumer attraction) after three days, even when it has been kept in cold storage and still appears fresh (Orchard and Ngwerume 2003). *Amaranthus*, on the other hand, is typically harvested at the 5-6 leaf seedling stage (Kolberg 1999) when it is still very tender and therefore unlikely to remain in good condition for any length of time. While these considerations do not totally preclude the possibility of marketing GLVs as fresh produce, they do suggest (combined with the short rain-fed production season and limited access to irrigation) that it would be better to start with preservation trials.

70. It is therefore recommended that GLV product development for formal and urban markets be concentrated at first on an investigation into the financial feasibility of preserving wild spinach by pressure-sterilising it in plastic pouches ("retort pouching"), which also suits out-of-season marketing. Initial investigations suggest that small commercial-scale retort pouching would not require exorbitant capital expenditure (probably less than 50c/pouch on 100 pouches a day capacity) and would be feasible (with some good staff training) in the technological environment of the NCAs (see for example http://www.digivu.co.za/safpp/DAH/technology.htm). To mitigate the dual risks of negative impacts on informal markets and/or procuring insufficient volumes for processing it is suggested that a few farmers be contracted to grow GLVs especially for the preservation trials.

71. The potential of various species to be marketed as fresh produce (especially their ability to stay fresh during collation and transport) can be investigated at the same time as retort pouching by selecting the best of the GLVs delivered for processing and subjecting them to various treatments (e.g. combined chilling, washing and disinfecting). Contracting growers would also allow a degree of control over harvesting and post-harvest practices. If these investigations prove successful, potential linkages with the National Horticulture Initiative and other ways to move the produce to urban markets rapidly should be pursued more actively.

72. In developing the ready-to-serve product there is probably some scope for experimentation with various recipes to cater for divergent tastes (e.g. some people will reportedly only eat *Amaranthus* in a mixture with *Cleome*, while others dislike the strong taste of *Cleome* and would rather eat young *Amaranthus*). An ideal combination would maximize the high yield potential of *Amaranthus* by combining it with just enough *Cleome* to impart a taste acceptable to the majority of traditional consumers. In South Africa canned *Amaranthus* is produced in many variations, including mixed with onions and/or tomatoes, combined with samp, or with chili (Dr J. Alleman, pers. comm.). One advantage of retort pouching is that it is a batch technology and therefore easily adapted to a wide range of products (the main constraint on the number of products being the cost of printing or labeling suitable packaging, relative to volumes).

73. While dried spinach is apparently not preferred by Namibian consumers, improved drying methods may result in a more acceptable product and should not be disregarded completely (H. Kolberg pers. comm.). A relatively simple but potentially very useful intervention would be trials aimed at improving production methods for *omavanda* so as to eliminate sand from the final product (C. Brock, pers. comm.). The CPHP project in Zimbabwe demonstrated the technical feasibility of solar drying, but found the process to be financially marginal despite strong market demand for dried spinach (Orchard and Ngwerume 2003). In Botswana *Amaranthus* is never cooked before drying, which could help to conserve nutrients (and fuel). Drying in the shade would help to conserve light sensitive nutrients such as Vitamins A and C.

74. Nutritional value and how best to preserve it in the processed product would be of special interest in connection with HIV/AIDS (H. Kolberg, pers. comm.). It may well be that the best food supplement is the raw, dried, powdered leaves of species not commonly eaten as a main part of the diet. However, complete nutritional analyses are expensive, not readily available inside Namibia, and hard to justify within VIVA's budget and time limits. Such analyses are one aspect of IVs that could benefit from HIV/AIDS related research funding.

75. In general terms the nutritional advantages of indigenous GLVs over exotic vegetables have been well documented (see e.g. Kolberg 1999 for a summary of analyses from the literature). In Kenya the potential of African leafy vegetables to fight micronutrient deficiencies formed one of the main pillars of the IPGRI programme to promote increased cultivation and consumption of GLVs and was reportedly well received by the target audience (to the extent that ALVs are now common in Nairobi supermarkets) (Maundu 2003). It is recommended that this nutritional superiority of IVs be underlined in public awareness campaigns, to educate consumers and facilitate other marketing efforts.

76. In Zimbabwe solar-dried vegetables have also been used for further value-adding at SME scale, by combining them with other ingredients into soup powders. This is a strong (but very price-competitive) market segment driven by the demand for convenience foods at the lower end of the income scale.

77. Among the popular indigenous GLVs at least *Cleome gynandra* could secure a large formal market on taste alone, but its keeping qualities are unclear (it is reported to lose its unique flavour after three days despite refrigeration). Until more is known about this aspect (as detailed above) commercial retailing will focus mainly on the products resulting from improved drying techniques and retort pouching.

78. At a minimum GLV products intended for commercial retailing must be free of sand. This sounds obvious but might be hard to ensure in practice, given the fine and tenacious nature of NCA grit, the sticky leaves of the target species, the general shortage of water in most of the traditional production areas, and the inclination of especially *Cleome* to lose taste if washed too much (H. Kolberg. pers. comm.). It almost goes without saying that all products must be processed using standard best practices for food products, and occasionally tested for microbiological safety. One advantage of pouching is that spoilage can be more readily detected than with canning.

79. In terms of labeling it is highly desirable to barcode products to facilitate retailing by the increasing number of supermarkets and other outlets with automated check-out points. For local marketing it would probably be sufficient to label the products with various names from Namibian vernaculars and the address of the processor. Access to export markets also requires a list of ingredients and a typical nutritional analysis of prescribed macronutrients. It might be advantageous to also include micronutrients that occur in notably high quantities. A "Naturally Namibian" mark would also be good, if it is available, while "Product of Namibia" would boost local sales.

80. It is recommended that both wet and dry products be packaged in heat-sealed plastic pouches or bags. This will allow a "cheap" version (no box, just a stick-on label) for national markets (where the products will face stiff price competition from the economies of scale achieved by South African mass producers) and a more expensive boxed version for export or other high-end markets. An effort should be made to test export markets in the African diaspora for such products.

81. For commercial retailing as fresh produce (if feasible) GLVs can be packed like Swiss chard (i.e. in quantities of about 400g inside perforated plastic bags or sleeves).

82. To promote sales and market penetration of GLVs an amount of N$50 000 has been budgeted for market research and development in 2005/06.

APPENDIX C

I.G.L.V.
PROGRESS REPORT
May 2005

1. Objectives reminder:

To find preservation alternatives for the four ILV species the most consumed in the NCRs (Ombidi - also Omboga -, Ekwakwa, Omundjulu and Mutete) in order to make them available as long as possible after the end of the rainy season with as little nutrient losses as possible. Let's recall the reader that only one traditional preservation method exists for Ombidi, Ekwakwa and Omundjulu generally mixed, involving long boiling time and direct sun drying (Evanda or Ekaka), most likely leading to a maximum loss of nutrients; furthermore, the way Evanda cakes are handled (not even protected by a simple plastic foil/bag) is likely to bring a maximum contamination.

2. Field work progress:

The field work and processing activities started in Ondangwa the 6/04/05 and were conducted over about one week.

2.1. ILVS and potential suppliers first approach: A previous identification of the four species had already been done as well as a short resource assessment in a few homesteads around mainly to make sure that the targeted ILVs were available in this area; many thanks to Thomas (KAP technician) who is native of this area and who greatly contributed to the success of the ILVS supply.

2.2. Intakes: a cucashop located at about 7 km south of Oluno was elected as the ILVS buying point. People around were requested to bring first the 3 most common vegetables - not planted - (Ombidi, Ekwakwa, Omundjulu). No price had been fixed in advance and it was anticipated that ILVs collectors would give a reasonable indication of the reward expected. The first batches of ILVs supplied were quite small; the quality was very good for some collectors, more questionable for others. If the supply was low the first day, it has drastically increased the next days when people saw that our offer was serious and prices fair, up to oversupply in some cases and for us to have to buy bags in lots because running out of change and money.

The Ombidi species has been the most difficult to source as it was already late in the season and also probably because it is one of the longest species to collect (small plants with a few leaves).

2.3. ILVS storage: the intakes were done during a quite hot period, with daily maximums of 35 to 36ºC. For this reason, ILVs collection was done very early in the morning by household manpower and the purchase generally started at around 9 pm. The MJP3 project's cold room was used to its maximum capacity to store the ILVS awaiting further process and it can be stressed that without a cold room, losses would have been high.

2.4. ILVS sorting: it has appeared very quickly that ILVs could not be processed as they had been bought and that a further sorting was compulsory; the fact that, at the inception, processing trials were slower

than supply and that ILVs had to be kept for 24, 48 or even 72 hours in the cold room, was one more reason to sort out the ILVS after storage and before further processing. Obviously, sorting is a time consuming job that can only be overcome with enough manpower. The main objectives of the sorting stage were to first control the quality and nature of the supplied ILVs and to discard damaged leaves or extra stems. Some species were mixed at the collection stage, but in a traditional way (except Mutete, the other ILVs are generally collected according to their availability in the field). We did not attempt to re-separate these ILVs mixes as quite always one of the species was predominant in the mix (generally Ombidi mixed with some Ekwakwa and Omundjulu). The sorting/separating stainless steel tables of the MJP3 project were well adapted also for this specific task. A team of five to 6 casual workers was permanently used during this first phase for initial checking and sorting.

2.5. ILVs washing: washing was done by species, generally after cold storage and just before processing; the same water was used as long as it was not too dirty. We used for that the MJP3's 60 or 70L plastic tubs and large colanders or baskets bought for this project. Leaves were poured in water, then manually stirred and left a few minutes to allow the heaviest particles (sand especially) to settle at the bottom of the tub; then, they were scooped by hand and put to strain in stainless steel baskets or colanders.

2.6. ILVs chopping/shredding: this step was not felt useful as blanching, especially in hot water, did not encounter any problem (it was feared at the project planning stage that leaves possibly could stick together and prevent the ones in the middle to be blanched. That has not been the case).

2.7. ILVs blanching: as planned in the processing alternative table, most of the ILVs were either water blanched or µwaved (except some drying trials with raw ILVS) to prevent the enzymatic destruction process. Then, bags of ILVs were cooled in tap water baths, chilled on the floor of cold rooms (EWC's cold room was also used) and finally deep frozen. At this stage, ILVs can be kept for several weeks in a deep freezer with a minimum loss of its organoleptic properties.

Leaves to be water blanched were weighed, then placed in a metal basket fitting into the stainless steel pot and dipped for 10 to 15 seconds into water at about 90 degrees, then drained and put straight into plastic bags that were sealed before to be cooled down, chilled and frozen.

µwaved leaves were first weighed, then placed in a plastic bag (the extra length of the bag folded down), then µwaved for 4 to 5 minutes, the bag was sealed, cooled down, chilled and frozen.

2.8. ILVs processing: from the second day of the intake, it became clear that the supply would be difficult to manage and regulate in order to get an appropriate ILVs flow, especially at this early stage when we had to make a lot of different trials. ILVs can be kept some 72 hours in a cold storage without significant and apparent damage, as long as the quality of the material was fair at collection time. The oversupply associated with compulsory trials and long preservation processes led to reduce as much as possible the range of initial trials and to a minimum processing that would allow safely bringing back ILVs in Windhoek and resuming there the trials.

3. Equipment ad equation and lessons learnt:

3.1. Equipment ad equation:

Most of the equipment planned or bought for this project have been successfully used; however, several MJP3's pieces of equipment have been extensively used (cold room, stainless steel water tanks and baskets, stainless steel sorting tables, plastic tubs and buckets, large sealer, shade net etc):

- The table's two gas burners are too weak and too much time is needed to bring or re-bring water to the boil. We fortunately took with us a powerful 3 ring gas burner which was used to water blanch most of the ILVs.
- The stainless steel table bought for this project is too small to hold sealers, scale, chipping boards and a few containers/colanders. The MJP3's sorting tables are also convenient for ILVs sorting and were extensively used.
- The vacuum sealer (domestic one, Magic Line VBS 540) is definitively too weak and small for even low production purpose. The compulsory "one and a half minute" resting time after each sealing delays production of samples, especially for pasteurized ones. Please, note that an industrial vacuum sealer costs at least N$ 10 to 12 000.
- Micro waving ILVs is most likely a better way of blanching the leaves (most likely less nutrient losses); however, here again, the small KAP's microwave (as well as the COSDEC's one) lacks of power and require at least 4 or 5 minutes at full power to blanch a 1kg bag of ILVs.
- Deep freezing large quantities of ILVs definitively requires a well ventilated freezing room. 48 to 72 hours are needed with domestic deep freezers to get the ILVs frozen if the quantity processed is a bit significant, and that even after cooling and chilling the ILVs bags in the cold room.

3.2. Lessons learnt:

- **Intake:** 4 different ILVs species were targeted. We now believe that one way to manage or regulate the intake, facilitating at the same time further processing is to request one species at a time and to notify suppliers that any other species would not be accepted/bought this day.
- **Losses at the sorting stage** (after storage and before washing) range for as little as 2% for Mutete and Omundjulu up to 21% for Ekwakwa (calculated on 30kg supplied) and to as much as 27% for Ombidi (calculated on 25 kg supplied). Heavy losses are specifically due to extra stems and seeds that are discarded at the sorting stage. Being not used to ILV processing and preservation, we had to trust our casual workers, mainly women.
- **ILVs quality assessment**: most of the suppliers were honest people just looking for extra cash from an unexpected opportunity. However, at least twice, we had bags of ILVS filled with mainly big stems and seeds (Ekwakwa). In order to prevent this type of fraud, it was later decided to transfer the ILVs from suppliers' woven bags or carton boxes to big transparent plastic bags before paying for them. Transparent bags allow to see what is inside and to quickly get an idea of the nature and quality of the leaves.

- **Raw ILVs storage**: when properly collected and bought early afterwards can be kept up to 72 hours in a well ventilated cold room at about 4 to 5ºC without noticing apparent damages (except lightly tossed leaves that recover when dipped in washing water).
- **ILVs convenient batch sizes**: 500g or 1 kg ILVs batches are easy to handle, to process and package. 1 kg plastic bags are fitting in small microwave ovens.
- **ILVS drying**: blanched ILVs take much less place and dry more quickly/easily than raw leaves (2 to 3 kg/m²)
- **Drying methods**: if raw ILVs can be dried on shade netting (50%), blanched ones can only be dried on plastic sheeting or on a fine stainless steel mesh. For evident reasons of better ventilation, the mesh is regarded as the best material, although it is much more expensive. We used stainless steel mesh to dry blanched ILVs.
- **ILVS packaging**: 80µ transparent vacuum bags are easy to use and bear well high temperatures, at least up to about 95°C (boiling water). Pasteurisation and sterilisation are easy to do if the bags are filled in such a way that their thickness does not exceed 10mm and if they are vacuum sealed. Heat exchange is quick, especially if these two steps follow immediately the blanching/micro waving stage (while ILVs are still hot).

4. Field work results:

4.1. Intake results: the ILV intake has started on the 6/04 (potential suppliers notified the day before), has continued the 7, 8 and 11/04. From about 20kg bought the 6/04, the supply has quickly increased to reach about 250kg the 11/04. The total supply has exceeded 400 kg of ILVs.

An attempt to get more Ombidi the 12/04 was fruitless probably because the season was already too advanced and this species was no more available.

4.2. ILVs average purchase price: for the 2 first days of intake, we did not use any scale, guess estimating the weight of the leaves brought by suppliers and weighing the bags back to COSDEC. It is for this reason that the total expense cannot be straight transformed in weight of ILVs. Later on, to avoid double work and also to bring more transparency in the transactions, we used the 60 kg scale of the MJP3 project.

In order to facilitate calculations, we did not introduce different prices for the different ILVs. It is a fact that whilst Ombidi, Ekwakwa and Omundjulu are generally not sown but only protected, Mutete is sown. Another consideration is that currently ILVs are not sold in a raw form and that there is quite no value attached to them. On the contrary, collecting the leaves is tedious and time consuming and this work deserves a fair remuneration. Mutete is probably the ILVs the quickest to collect (large and relatively numerous leaves on the same plant) justifying a purchase price not higher than for other ILVs.

The 6/04, 20 kg of Ombidi and Ekwakwa were bought for a total amount of N$ 130.00, meaning N$ 6.50/kg.

The day after, 42.2 kg of Ombidi and Ekwakwa were bought for a total amount of N$ 430.00, meaning N$ 10.20/kg.

In order to make calculations easier, we decided to set the price/kg – weighed - at N$ 10.00 (for the three ILVs species not sown, and according to what we were told, we may assume that it takes about 1½ hour to collect 1 kg of them. Transport time to the purchase point has also to be taken into consideration. Therefore, an adult collecting 4 kg of ILVs and spending two hours to reach the purchase point and return home gets N$ 40.00 for an 8 hour working day, exactly what we paid our casual workers.
However, due to change and money availability at the purchase point, we had a few times to buy large quantities of ILVs at discounted price (but with the agreement of the suppliers): 26 kg of Ekwakwa bought to 8 suppliers in one lot for N$ 80.00 the 8/04, 38kg of Mutete bought at N$ 300.00 the 11/04 are two examples among others.
Finally, a total of N$ 3 577.00 was spent for about 400 kg of ILVs, meaning an average price per kg of almost N$ 9.00.

4.3. ILV processing: all the processed ILVs were first stored in the cold room, before sorting, washing and for most of the supply, blanching. As already said, chopping or shredding did not appear useful and then was dropped. Each planned type of processing (see the "ILV processing alternatives" chart in ***annex 1***) is described below with the quantity of ILVs involved:

- **Drying (N°1 and 4 in the table):**

(1): Drying of raw material, without previous blanching: ILVs to be dried were washed, drained and spread on a shade net laid on the drying platforms at COSDEC. Please note that the drying platforms are in a roofed and ventilated building, therefore in the shade and protected from rain. Drying ILVs were stirred 2 or 3 times a day. The advisable "load" is about 3 kg/m² of fresh leaves. It has however to be stressed that the required drying surface decreases with ILV getting dryer.

Available samples:
- Ombidi: 1 bag 525g, 2 bags 100 and 110g; total 735g
- Ekwakwa: 1 bag 688g, 1 bag 260g, 1 bag 82g; total 1030g
- Omundjulu: no sample (succulent like), so difficult and long to dry.
- Mutete: 1 bag 640g.

Weight reduction:
- Ombidi: 735g dry from 6310g raw = 11.65%
- Ekwakwa: 1030g dry from 5160g raw = 19.96%
- Omundjulu: not dried
- Mutete: 640g dry from 4500g raw = 14.22%

Packaging: dry raw ILVs have been vacuum sealed in 80µ transparent plastic bags and stored at room temperature in a carton box to avoid the detrimental effects of light (discoloration and vitamin losses). Black, aluminium lined or opaque plastic bags would have probably been better for ILV storage although they prevent to visually assess the condition of their content.
Comment: drying time is long with raw ILVs (up to 96 hours or more, depending on the weather and air moisture. It has also be noticed several times that leaves that were felt dry and that were packaged had

to be removed from the bags for a second drying period of 12 to 24h (Ekwakwa especially).

(2): Drying of raw material after blanching: ILVs to be dried were washed, drained, then dipped for10 to 15 seconds in water at around 90ºC and again drained for a few seconds. Afterwards, blanched ILVs were made loose and spread on a fine stainless steel mesh laid on the drying platforms. There were stirred two times a day.

Available samples:
- Ombidi: 1 bag 400g, 1 bag 345g, 1 bag 310g, 1 bag 90g; total 1145g
- Ekwakwa: 1 bag 190g, 1 bag 240g; total 430g
- Omundjulu: no dry sample yet.
- Mutete: 1 bag 506g.

Weight reduction:
- Ombidi: 1145g dry from 10 620g raw = 10.78%
- Ekwakwa: 430g dry from 2100g raw = 20.47%
- Omundjulu: not dried
- Mutete: 506g dry from 3340g raw = 15.15%

Packaging: dry blanched ILVs have also been vacuum sealed in 80µ transparent plastic bags and stored at room temperature in a carton box to avoid the detrimental effects of light (discoloration and vitamin losses).

Comment: drying time (48 to 96 hours) is generally shorter with blanched ILVs - except for Mutete (we reached 120 hours of drying time in the shade) because it is very difficult to separate/loosen the leaves stuck together at the blanching stage -.

Required drying space is much lower than with raw leaves, but the shade net is not appropriate and either a plastic sheeting or a fine stainless steel mesh have to be used (more frequent stirring is required if a plastic sheeting is used). It may also be stressed that ILVs dried after blanching feel brittle and drier than raw ILVs and their colour is darker.

It is also worth noting that Ombidi, Ekwakwa and Omundjulu leaves keep their green colour (or darken) when blanched; to the contrary, Mutete leaves become light brown when blanched but surprisingly recover their green colour after a few weeks in the deep freezer.

- **Lactic fermentation (Nº2 and 3 in the table):**

several attempts were done to preserve raw or blanched ILVs this way but failed (bad smell developing after a few days/weeks) mainly because the containers that were used (mainly plastic wide-mouthed jars) were not appropriate. Lactic fermentation is anaerobic and requires special containers preventing the fermenting material to get into contact with air. The main constraint is that fermentation increases the level of material and liquid in the container leading to loss of liquid and when fermentation decreases, there is no more enough liquid to cover the material; this one rots and then stinks.

New trials are in progress with 5L PET plastic bottles topped with an expansion like tank, allowing the liquid level to move up and down with always enough to ensure that ILVs do not get uncovered (this system worked well with chopped marula skins; the only problem with ILVs would be to remove them from the bottle).
Nº2 processing method was ILV lactic fermentation and preservation in the fermenting container.
Nº3 processing method was the same method, but ILVs would have been transferred in an air tight container after fermentation and pasteurized to ensure a long preservation period. It has to be stressed that pasteurization kills the lactic bacteria and thus destroys their healthy effect.
Pasteurization of lactic fermented ILVs would be conducted if fermentation succeeds.

Available samples: not yet availabe

Weight evolution: not yet known

Packaging: 5L PET bottles for method Nº2 or either plastic bags or glass jars for method Nº3.

- **Deep freezing of blanched/µwaved ILVs (Nº5 and 6 in the table):**

Except for Ombidi that was the less supplied ILVS, all the other species were both water blanched and µwaved before cooling, chilling and deep freezing.

Available samples:
- Ombidi: 15 kg in 500g bags
- Ekwakwa: 46 kg in 500g and 1 kg bags
- Omundjulu: 130 kg in 500g and 1 kg bags
- Mutete: 160 kg in 500g and 1 kg bags

Weight evolution: for µwaved samples, theoretically no changes in weight as fresh ILVS are filled into a plastic bag that is then folded back. The bag is thereafter immediately sealed.
Water blanching does affect the weight:
- Ombidi: light increase of the weight from 500g to 520 g = + 4%
- Ekwakwa: light weight reduction from 500g to 490g = - 2%
- Omundjulu: the highest weight reduction from 1000g to 915g = - 8.50%
- Mutete: light weight reduction from 1000g to 975g = - 2.50%

Packaging: all the blanched/µwaved ILVs have been sealed in 80µ transparent plastic bags after blanching (with as little air as possible) and stored in two deep freezers (currently at KAP)

Comment: the 2 deep freezers bought for this project are filled at full capacity (and a third - small- one had to be borrowed to store all the ILVs). It is expected that the deep frozen vegetables keep all their nutritional and organoleptic properties, at least for a few months.

- **Pasteurization and sterilisation: (Nº7 and 8 in the table):**

It was planned to pasteurize and sterilise ILVs in glass jars. However, cooked ILVs without any seasoning are not really appealing and these processes are time consuming. We believe that before pasteurizing/sterilising the vegetables, it is better to prepare ready cooked dishes (from frozen ILVs). For that (and with a view to prepare what is going to be proposed to the panel tasting) several mixes have to be tried (ILVs cooked with tomatoes, onions, meat, fish, potatoes…) and pasteurised or sterilised afterwards.

Available samples:

Pasteurization trials have been done with 500g bags of Ombidi and Ekwakwa (blanched, packaged, vacuum sealed, pasteurized in the plastic bags in hot water (2') and cooled down, then kept in the cold room.. We still have a few kg of pasteurized Ekwakwa in the cold room and up to now, they do not seem damaged. Unfortunately, the bags of pasteurized Ombidi have inadvertently been stored in a deep freezer.

Available samples:

- Ekwakwa: 8kg in 500g plastic bags.

Comment: tests to be conducted to assess the leaves condition, aiming at determining the shelf life for this species processed this way. Further pasteurisation trials would be useful on other species if they can be made available.

- **Retort pouching: (Nº9 in the table):**

No special pouches could be made available at this stage. It has, however, to be highlighted that without a sophisticated and very expensive (and productive) equipment, this process would take a lot of time. Retort pouching is normally a very quick heat treatment (130ºC and more under pressure) for a few seconds; as the pouch is fine, heat exchange is very quick. However, doing that in a pressure cooker requires to place the sealed pouches in warm water in the pressure cooker, then to heat the water under pressure at about 130ºC and to allow water and pouches to cool down (if the pressure in the cooker is suddenly released while the temperature is still high, the pouches would burst).

- **Solar dryer:**

The solar dryer prototype, planned in the budget has been built and works. It has not been extensively used in Ondangwa because of the large quantity of ILVs to be processed in a quite short time. However, further tests are planned with thawed ILVs. The two main constraints attached to the solar dryer are the relatively low drying surface (1.15 m² shared between 8 trays) meaning low productivity and on the other hand the need to have somebody available to load, move and unload the trays, and to adjust the heat absorber direction to follow the course of the sun.

5. Laboratory tests:

One fresh sample of each ILV has been sent to Windhoek for tests (collected the same morning, placed in a cool box with ice and sent by plane; the sample was at the laboratory at 11am).
Other tests of processed ILVs (dried, pasteurized, frozen) will follow soon to assess the nutrient losses, if any, and to detect and measure possible contaminations.

6. **First conclusions:**

The inception of this project, and especially the field work, has shown that leafy vegetable resource exists in rural areas and that communal farmers are happy to sell part of their production at affordable prices.
The first intakes have been a success, despite oversupply for Omundjulu and Mutete. Answers have been found to some problems experienced during these first intakes (oversupply, ILV quality) and are considered as learnt lessons.
Some pieces of equipment definitively have to be included for new/further phases: a well ventilated cold and freezing room, plastic tubs and buckets, powerful gas burners, powerful μwave oven(s), an industrial vacuum sealer…
On the processing side, despite some slowness at the beginning due to trials, most of the ILVs bought have been sorted and processed.
Casual labour, especially women, needs to be taken into account for sorting, blanching, packaging, labelling and storage.
The storage of ILVs after blanching and freezing in deep freezers will allow continuing secondary processing with quality material.
Although laboratory tests have not yet been done on processed ILVs, it is expected that their quality would be much higher than the one of the traditionally preserved Ekaka.
Dissemination of simple ILV processing and preservation methods through COSDEC (Home Economics), Associations (EWC), development projects and even schools would be the best way to develop ILV farming and improve nutrition in Namibia.
Secondary processing would be soon initiated in order to demonstrate that beyond their nutritional value, ILVs can also be prepared in an appealing way.

APPENDIX D

IGLV market research

Methods

- **Panel testing Outapi market**

1a. Set up

The different conservation methods of the IGLV were compared by consumers in panel test at the open market in Outapi. The panel consisted of 15 people, 5 rural consumers, 5 urban consumers, and 5 foreigners who had never eaten the IGLV before. Three women who normally prepare and sell food at the open market, prepared the IGLV in the traditional way, and provided valuable feedback on the smell, taste, texture, appearance, convenience, cooking time, and preference of conservation method.

Before the panel test, the panelists were asked to fill in a simple questionnaire about the usage of IGLV. The panel test consisted of 4 rounds, and in every round the panel testers had to taste and rate 3 colour coded plates. The vegetables were rated on smell, taste, texture, and appearance on a scale from 1 (horrible) to 7 (excellent). The panelists were motivated to add comments to the ratings, and were asked at the end of each round which plate they liked most, and why.

Each of the 4 rounds consisted of 1 type of vegetable with different conservation methods, but prepared in the same traditional way. The 6 different conservation methods were all used twice, except for the lacto-fermentation which was only available for Omutete. The following rounds were done:

1 Omboga / Ombidi pure
- -Raw, dried *(blue plate)*
- - Blanched, dried *(red plate)*
- - Cooked and sterilized in jars *(green plate)*

2 Omutete
- - frozen *(blue plate)*
- - traditional *(red plate)*
- - lacto-fermented *(green plate)*

3 Ekwakwa
- - cooked and sterilized in jars *(blue plate)*
- - dried, raw *(red plate)*
- - frozen *(green plate)*

4 Omboga, mixed with Ekwakwa and Omundjulu (as it is traditionally eaten)
- - traditional cakes *(blue plate)*
- - cooked and sterilized jars (Omboga and Ekwakwa only, omundjulu not available) *(red plate)*
- - dried, blanched (Omboga and Ekwakwa, mixed with frozen Omundjulu) *(green plate)*

1b. Factors influencing the panel test research

In handbooks describing panel test methodology (i.e. E. Larmond – *Laboratory Methods for Sensory Evaluation of Food,* Food Research Institute Ottowa, 1982), it is said to be important for the validity of the research that panelists are relatively isolated, be seated on comfortable chairs, in a neutral atmosphere, with correct lighting and a constant and comfortable temperature. It is furthermore important that panelists are not hungry, not distracted, and not entering into conversations of any kind.

Controlling these factors at the open market in Outapi is simply impossible, and the panel testing was culturally adapted by keeping it as simple as possible, and by telling the panelists to:

A. Be honest, it was explained that we were not looking for compliments, but that we needed their honest opinion. It was made clear that neither the researcher nor the cooks would be offended if they didn't like the dish.
B. Give their own opinion, without discussing it with other panelists
C. Merely smell and taste the GLV during the test. It was clarified that they would get 12 plates to taste, and that they should not be full in the middle of the test. It was also said that they could eat as much Oshifima and IGLV as they wanted, after they completed the tests

Apart from the disturbing factors unavoidably present at the market, the following factors also influenced the results:

1. It was difficult for most panelists to constantly separate taste from smell, texture and appearance. A dish that tasted good would almost invariably result in high ratings for the smell, texture and appearance, and vice versa. For example, 'excellent' tasting omboga would score 7 points on appearance as well, and Omutete that panelists rated as 'horrible' in taste, would score a 1 on appearance. Still, the two different dishes didn't necessarily *look* very different. Generally, taste was the decisive factor in most of the ratings.
2. Although all dishes were prepared in a similar way, there were accidental differences in the amount of oil or salt added. Some of the ratings were done on the basis of these variances, rather than the conservation method.
3. The fact that the dishes were prepared in a traditional way, by cooking them for a long time and adding a lot of oil, made the foreign panelists less appreciative of the IGLV. Their ratings were extremely low, compared to the ratings of the same target group that participated in the cooking trials in Windhoek, where they were allowed to prepare them in their own way.
4. Omutete is an IGLV that is unknown in the area where we conducted the panel test. The cooks didn't know how to prepare Omutete, and when cooked in the same way as Omboga and Ekwakwa, it is very sour. The ratings of omutete were extremely low, not only because it has a taste that people were not used to, but also because it was not properly prepared. A small panel test of Omutete was therefore repeated in the Windhoek cooking trials.
5. Because the omutete dishes were experienced as 'bad' to 'horrible', the dishes that were served immediately after that (i.e. bottled Ekwakwa) were probably rated higher than what they would have been if they were served in a different order. Similarly, after a dish with an 'excellent' taste, dishes that would otherwise be rated as 'good', could be rated as 'average' or even 'bad'.

6. The panelists were generally more excited to participate at the beginning of the test, and got a bit bored during later rounds. This resulted in some panelists getting more indifferent and less accurate in their ratings and comments. It may also have an influence on the ratings in general; if you like a certain dish, the first plate is likely to taste better than the 10th plate.

- **Cooking trials in Windhoek**

From the Outapi panel test results it became clear that appreciation of the IGLVs is largely depending on the way in which the vegetables are prepared. It was therefore decided to do a number of cooking trials instead of conducting yet another panel test. In the cooking trials a variety of people from different ethnic backgrounds and different potential market segments, were given a variety of IGLVs, which they could prepare in their own way. The participants were asked to rate and compare conservation methods, vegetable species, or both. They were furthermore asked to experiment with the vegetables, and to record their recipes. After their trials semi-structured interviews were conducted in order to get their opinion about potential marketability of the IGLV. The results of the cooking trials, which are more qualitative than quantitative, proved to be a very valuable source of information.

Comments Panel testing – Market Outapi

1a. Omboga – dried, raw

Cooks:

- Smells ok when opening bag and while cooking, problem is that it stayed hard, had to cook it for 1h30, and a lot of water needed to be added

Panel testers:
Big branches / particles x 4 (i.e. too many stems)
Too sandy x 3 (comments all by foreigners)
Not much smell x 2
Too soft
Nice soft
Smells better than it tastes
Not enough oil
Looks very nice, but horrible taste
Doesn't look good, and no nice taste

1b. Omboga – dried, blanched

Cooks:

- Smell very nice when opening bag, cooks fast (20-30 mins), nice dark colour and texture (soft) when cooked. Much more preferred too the raw dried both in cooking and the end result

Panel testers:

- Big branches x 3 (i.e. too many stems)
- Excellent! (traditional) x 2
- Too salty
- Soft but too sour
- Excellent taste and smell, texture so so
- Bit sour
- Bit thick
- Taste too strong and bitter

1c. Omboga – cooked and pasteurized (jars)

One of the jars (without salt) looked a bit white on top and smelled more like beans than spinach

Cooks:

- Liked the smell of both jars. The jars were mixed and cooked for 25-30 mins, but it was said that they could eat the spinach just like it came out of the jar. Taste characterized as very nice and very fresh (favorite among the 3 ombogas), problems were the abundance of stems, and the presence of sand

Panel testers:

- Too many branches x 2
- Not cooked enough x 2
- nice soft x 2
- Too black x 2
- Very fresh
- Taste too strong, bitter and sour
- Sandy
- Colour and smell to be improved

2a. Omutete – frozen

Cooks:

- The smell when opening was ok, but the cooks didn't like the taste, said it was too sour. It had to be cooked for 30-35 mins. Appearance and texture ok, smooth.

Panel testers:

- Too sour x 7
- Bad to eat / bad taste x 5
- Texture nice and smooth / soft x 3
- Bitter taste x 2
- doesn't look good x 2
- Appearance good

2b. Omutete – traditional

Cooks:

- Taste a bit better, but looks too dark, and texture too hard. It cooked for 25-30 mins

Panel testers:

- Too sour x 8
- Bad to eat / horrible taste x 4
- Very bitter x 3
- Very dark x 2
- Lot of particles x 2
- Smelling bad
- My God!
- hard
- Texture fine and smooth
- Appearance very good

2c. Omutete – lacto-fermented

Cooks:

- The lacto-fermented omutete was preferred by all cooks in smell, taste, appearance and texture. Nice and soft, and not too sour. It cooked for 20-25 mins

Panel testers:

- Bad taste / horrible x 5
- Sour x 3
- Good in texture x 2
- Lot of particles / branchy x 2
- Bitter
- Stingy
- Soft
- Slippery
- Good appearance
- Sandy

3a. Ekwakwa - cooked and pasteurized (jar)

Cooks:

- The cooks liked the taste, smell, and texture of the Ekwakwa when opening the jar. It was said it could be eaten straight from the jar, but it was cooked for 20-25 mins to make it more soft and smooth

Panel testers:

- Sandy x 3
- Soft x 2

- Sticky
- moist
- Bit too crunchy, otherwise nice
- Very good and fresh
- Not nice
- Good taste
- Like traditional
- Looks good

3b. Ekwakwa – dried, raw

Cooks:

- Smell not bad when opening the bag, but this sample of ekwakwa not preferred by the cooks. It has the worst taste, smell texture and appearance, and had to be cooked longer (45 mins) than the other 2

Panel testers:

- Tasting nice x 3
- Good smell x 2
- Crunchy / branchy x 2
- Bit soft / nice soft x 2
- Sandy x 2
- Bit hard
- Bad smell
- Bit sour
- not good to eat
- Looks good, but not nice to taste

3c. Ekwakwa – frozen

Cooks:

- Good smell and colour (very green), and very good taste, the only problem they felt was the abundance of stems. It was cooked for 25-30 mins, and this plate of Ekwakwa was preferred by 2 of the 3 cooks (the other one preferred the Ekwakwa from the jar)

Panel testers:
Nice soft x 3
Lot of particles / branches x 3
Not nice to eat / very bad x 2
Taste too strong x 2
Bit sour
Very good taste and appearance
Nothing special

4a. Omboga mixed with Ekwakwa and Ekundu – traditional cakes

Cooks:

- Taste and smell good, as they know it. Texture and appearance was rated lower than the other two types, and they said they preferred the jars and the frozen vegetables for cooking. Cooked for 45 mins

Panel testers:

- Excellent / very nice to eat x 6
- Like the traditional one x 3
- Sandy x 3
- Aftertaste bad x 2
- Hard x 2
- Too soft
- Crunchy but good
- Black, but nice
- Not fresh
- Spicy and oily

4b. Omboga mixed with Ekwakwa – cooked and sterilized jars

Although it was intended to add Omundjulu to the mix as is traditionally done, or Ekundu as was added in the traditional cakes used, neither species were available in jars, and only Omboga and Ekwakwa were mixed

Cooks:

- Two tins of Omboga and one tin of Ekwakwa were mixed and cooked for 40 mins. Smell, appearance and texture of the mix were rated very high.

Panel testers:

7. Excellent / Good to eat x 3
8. Nice soft x 2
9. Taste and smell horrible
10. Bad aftertaste
11. Strong taste
12. Too soft
13. A bit hard
14. Nice smooth
15. Too fine
16. Particles
17. Too oily

4c. Omboga and Ekwakwa – blanched, dried, mixed with frozen Omundjulu

No blanched dried Omundjulu or Ekundu were available, and it was decided to add some frozen Omundjulu to the mixture. However, 2 types of Omundjulu can be found, one for human consumption, and one for animals, and after the Omundjulu was added, it was suspected that it was the wrong type, which influenced the taste badly

Cooks:

- The mixture was cooked for 35 mins. It was said that the branched Omboga gets better, more smooth, when Omundjulu is added, and that it cooks faster as well. The texture of this mixture was therefore more preferred compared to the other mixtures. They had serious problem with the taste though, because the wrong type of Omundjulu was used.

Panel testers:

- Nice soft / smooth 4
- Branchy 2
- No smell 2
- Good taste 2
- Bad taste 2
- Bit sour 2
- Strong bitter taste
- Too green
- Sandy
- Not sandy

Comments from the Cooks – Outapi Market

The cooks at Outapi market prepare and sell IGLV on a regular basis, they say it is quite popular. They use either the dried cakes (Omahanda), or fresh vegetables. It is sold for N$ 0.50 per spoon.

Of all the samples we provided, they preferred cooking the frozen and cooked / pasteurized IGLV, because they cooked fast, used little water, and the taste was preserved.

Some of the samples were not liked because they contained of a lot of stems. Similarly, the presence of sand was not appreciated either. Although people are generally used to having sand in traditional food, and in our panel test it were mostly the foreigners that noted the sandiness of the different samples, it was said that an effort should be made to remove all sand before processing.

Their favorite recipe with IGLV is:
* Using a mixture of IGLV; Omboga / Ombidi (60-70%), Ekwakwa (20-30%), and Omundjulu (10%). A mixture of the vegetables makes it taste better and cook better (Omboga alone is a bit hard, it becomes softer and smoother when one adds the other two)
* Adding fresh tomatoes and onions
* Adding ondjove (traditional marula oil) preferably, if not available one can add milk fat (2nd), margarine (3rd), or cooking oil (least preferred)
* cooking the mixture for about 30 minutes until it's smooth and soft (regardless whether one uses fresh vegetables or cakes)

General usage of IGLV
(Results general questionnaire panel testers - market Outapi)

Of the 15 Panel testers, 9 respondents filled in the general questionnaire about IGLV usage (5 foreigners excluded, 1 blank)

1. Do you eat any of the following vegetables:

Omboga (mixed with ekwakwa / omundjulu)	YES	9	
	NO	0	
Omboga (pure, not mixed)	YES	6	
	NO	3	(very sour)
Ekwakwa (pure, not mixed)	YES	9	
	NO	0	
Omutete	YES	4	
	NO	5	(not known / not available)
Iihwiki	YES	5	
	NO	4	(not known x 3) (too sweet x 1)
Ekundu	YES	9	
	NO	0	

2. Which one do you like best?

Omboga, mixed	5
Omboga, pure	2
Ekundu	2

3. How often do you eat them?

more than once per week	8
once per week	0
once per month	1
seldomly	0

4. Do you eat them throughout the year or only in a particular season?

throughout the year	8	
only when they are available	1	(from December till March)
only when there is nothing else	0	

5. Where do you get these vegetables?

mostly get them from my own field	7
mostly get / buy them from relatives or friends	1
mostly buy them at the market	1

6. Do you sell omahanda?

YES 7 (note that many of the panel testers were market women)
NO 2

If yes:

Where do you sell them?	At open market	6
	the community	2
How much do you sell?	N$ 250.00 / year	1
	N$ 0.50 / cake	1
	N$ 2.00 / cake	3
	N$ 2.50 / cake	1
	N$ 4.00 / cake	1
From where do you get them?	From own field	5
	From friends / relatives	2

7. How long does it take to cook omahanda?

10 minutes	2
15 minutes	1
30 minutes	6

8. What is your favorite recipe, using omboga, Ekwakwa, Omutete, and/or Omundjulu?

(describe which vegetables are used, how long they are cooked, what ingredients are added and any other particulars)

Use Omboga	7
Use Ekundu	2
Add water, salt and cooking oil	9
Add fresh tomatoes and onions	5
Add green pepper and peri peri /chili	1
Add ondjove (marula oil)	1
Add milk fat instead of oil	1
Add rama margarine instead of oil	1
Add soup	1
Cook 30 minutes	5
Cook 15 minutes	1
Cook 10 minutes	3

Cooking trials Windhoek

Instead of doing another panel test in Windhoek, it was decided to do some more in-depth and open-ended market research with representatives of various consumer groups. The panel testing in Outapi did not give much clarity on the marketing opportunities outside of the traditional users, as it appeared that the appreciation of the vegetables was depending on the way the vegetables were prepared, rather than the

type of vegetable or the way in which it was processed. The panel testers that were unknown to the IGLVs, were not very appreciative of the vegetables, because they were prepared in a traditional way; cooked for a long time, with a lot of oil added. The cooks in Outapi furthermore were not familiar with the vegetable Omutete, and prepared it in the same way as they prepare the known vegetables, which would not even have been appreciated by those who normally enjoy eating Omutete. It was therefore decided to do a number of cooking trials in Windhoek, where people could prepare the vegetables in the way that they like it.

People from different potential market segments with different ethnic backgrounds were asked to prepare and taste IGLV, and compare and rate different conservation methods, different types of vegetables, or both. Others were asked to experiment, and come up with recipes (see appendix / paragraph XX). The people participating in the cooking trials were furthermore asked about the potential marketability of the vegetables, whether they would buy IGLVs if they were available, what species, in what form, and for what price.

1. *MK (m), Cameroonian chef and owner of "le Marmite", a well known African restaurant in Windhoek was asked to experiment with recipes, and to do a comparison of both processing methods (Ekwakwa frozen, dried, sterilized, and lacto-fermented) and species (frozen Ekwakwa, Ombidi, and Ometete).*

Preference: MK showed a strong preference for the frozen vegetables, as freezing preserves the taste much better and keeps it fresher than any of the other conservation methods. In his restaurant he never uses dried, canned, or bottled food. He liked all 3 of the species, although he found omutete a bit less attractive in appearance because of its colour. He furthermore added that Ombidi and Ekwakwa were very similar and could be used in a variety of dishes, while Ometete has a more specific taste and can only be used in few particular dishes.

Marketing: MK was very firm in saying that he would buy the 3 different vegetables in frozen form if they were available, provided there is no sand in them, and the price is reasonable and competitive with other vegetables (around N$ 5 per 500 gr. packet). He would not replace the conventional spinach in his dishes with IGLV, as the taste is very different, but rather add new dishes to his menu, containing IGLV. He furthermore added that the packages should be small (500 gr. would be convenient).

2. *EK (f), Oshiwambo speaking, and a trained cook with experience in a number of Western style restaurants, now running her own catering company, was asked to experiment with, and to rate and compare the different conservation methods of Ombidi (frozen, dried, sterilized, and lacto-fermented).*

Preference: EK enjoyed both the frozen and the dried ombidi. She had a slight preference in taste for the dried ombidi, and preferred to cook the frozen ombidi, adding the frozen variety is more convenient for caterers. Both jars (sterilized and lacto-fermented) were found to be a bit less appetizing. Although the taste was not that bad, she felt the bottled vegetables had lost their natural colour, and expressed a concern about the expiry date.

Marketing: EK said she would definitely buy both the frozen and dried omboga if they were available. She feels people like IGLV, but she hardly ever cooks them now, because it is a hassle to get them from the informal markets, and she has strong hygienic concerns about the processing, storage, and sales of the traditional dried cakes. The traditional cakes furthermore contain a lot of sand. An acceptable price for her would be N$12 per 500 gr. frozen packet, or for a similar amount of blanched & dried ombidi.

3. *A number of cooks in a soupkitchen in Katutura, from different ethnic backgrounds, were asked to compare and rate the different conservation methods (frozen, dried, sterilized, and lacto-fermented). They tested mixtures of Ekwakwa and Ombidi (which are usually mixed in the Owambo tradition) that were tasted as such and mixed into a soup.*

Preference: Although skeptical at first about the frozen IGLV, the cooks were unanimously excited about its taste and agreed that it was by far the best conservation method, as it kept the IGLV more fresh. As second best some of the cooks chose the dried varieties, while others definitely preferred the vegetables from the sterilized jar. The lacto-fermented vegetables were not much liked.

Marketing: The cooks said they would love to use the frozen IGLV more often, but in the absence of a freezer, they would opt to buy the dried Omboga and Ekwakwa. N$10 for a small packet was considered a reasonable price. They furthermore suggested that the IGLV should be procured and processed from December till February, as they taste best during that time.

4. *FSA (f), Oshiwambi speaking urban consumer was asked to rate and compare the different conservation methods of Ombidi. The Ombidi was prepared in a traditional way.*

Preference: FSA and her family definitely preferred the frozen ombidi, because it tasted as if it came fresh from the field, the cooked and sterilized ombidi came in as a very good second, and the dried and lacto-fermented varieties were rated as excellent in smell and appearance, but didn't have such a good taste. The dried ombidi furthermore took much longer to prepare.

Marketing: FSA feels that there is a market for the frozen and cooked ombidi, because they keep the taste of fresh ombidi, more than the traditional dried cakes, and are easier to prepare. FSA would buy both the frozen and bottled Ombidi, if they were available, and the prize would be less than N$ 10

5. *MK (f), urban consumer who grew up in the Kavango region, did a small panel test with 4 people in Katutura on Omutete prepared in the Kavango tradition. Four different conservation methods were rated and compared; traditional, frozen, sterilized, and dried.*

Preference: The panelists all preferred the frozen Omutete, because it was very smooth and tasty. The traditionally dried Omutete was rated second because of its

well known taste, and the bottled and blanched and dried varieties were a bit less appreciated. MK preferred cooking the frozen omutete.

Marketing: The panelists said they would like to buy and prepare the frozen omutete more often, but none of them owned a freezer. They would therefore rather stick to the traditionally dried omutete, which is readily available in their area, and very affordable

> *6. ABK (f), an urban consumer from a European background, with a flair for cooking healthy, creative dishes, was asked to experiment and compare the three different species that were all given in a (blanched) dried form.*

Preference: ABK preferred Ekwakwa, because it had the best taste, a nice green colour, a mild flavour, and was the least sandy. Ombidi was also enjoyed, and although she experimented extensively with different recipes, ABK said that both vegetables tasted good after just boiling them shortly. Omutete did not taste nice on its own, and would need a sweetening herb. It was furthermore a bit mushy, and rated to have a bad colour, but it was said that because of its lemon flavour, it could be very nice in certain dishes, like stews and scrambled egg stir-fry (see recipes).

Marketing: ABK prefers cooking with fresh vegetables, but if it was available, she would buy Ekwakwa in dried form, especially to be used while camping. An acceptable price would be N$ 5 for a small packet. She feels there is market potential for the IGLV, but that it would need a considerable marketing effort, as people in general are very conventional when it comes to food, and they rather stick to what they know. Ombidi and Ekwakwa would be easier to market than Omutete, as they can be eaten on their own, and can replace conventional spinach in known dishes

> *7. JC (f), an urban consumer with experience in the health food catering industry, was asked to experiment with Ekwakwa and Omutete that were both given in 4 different forms (frozen, dried, sterilized, and lacto-fermented)*

Preference: JC did not have time to experiment with all the vegetable samples given, but her favourites were definitely the lacto-fermented and cooked and sterilized jars of Ekwakwa. Although the smell at first put her off a bit, she called the taste of the bottled Ekwakwa ‘divine’. The taste of the frozen Ekwakwa was good as well, but the fact that the bottled Ekwakwa could be eaten straight from the jar, as a healthy snack or mixed in salads, made the jars her favourite. She furthermore felt conventional spinach could easily be replaced by Ekwakwa in lasagne or other dishes containing spinach. The lacto-fermented and cooked and sterilized Omutete had a better smell than Ekwakwa, but the taste was way too sour to be eaten as such. She was however going to try using the omutete in dishes that normally require lemon juice, like chicken casserole.

Marketing: JC prefers to use fresh vegetables and normally doesn’t buy vegetables that are frozen, dried, or canned, both because of nutritional value and taste. She said

she would however definitely buy Ekwakwa in jars, because of its convenience, and exceptional taste. An acceptable price for her would be N$ 12 – N$ 15. She also suggested taking samples to the organic market in order to introduce the IGLV to potential customers in the health food sector**.**

> *8. SD (m), a volunteer from Sri Lanka, used to adding leafy vegetables to his food (over 100 species used in Sri Lanka), participated in the testing panel in Outapi. He didn't like the way in which the cooks had prepared the IGLV for the trials, and requested to prepare and taste them in his own way.*

Preference: SD experimented with frozen Ekwakwa and Ombidi. Ekwakwa was fried with fish, and Ombidi was cooked in a stew with soya, onions and tomatoes. Both IGLV were appreciated equally.

Marketing: SD would buy Ombidi or Ekwakwa, if they were available in the supermarkets and the price would be comparable to other available vegetables. He advised on starting with small packages stating proper nutritional information. He would buy either the frozen or dried variety, but said he would probably opt for the dried IGLV, for reasons of hygiene.

Price analysis

Several IGLV were bought at markets in Katutura (Single Quarters and Okuryangava), Oshakati (Omatala) and Outapi (the open market and a more informal market) in July 2005. Fresh IGLV were not available at this time of the year.

*** Omboga / Ombidi** was available in all markets, mostly in the form of dried cakes (Eewanda) but in some places also loose (dried). In almost all cases, the omboga cakes also contained Ekwakwa, and a bit of Omundjulu.

The ***eewanda*** is sold per cake, rather than weight, and customers will obviously pick the largest cakes from the stock first. The weight of the omboga cakes that we bought varied from 25gr to 62gr with an average of 45gr. The price of these averaged sized cakes varied from N$ 1 - N$ 2 in Outapi, to N$ 2 – N$ 3 in Oshakati, to N$ 4 – N$ 5 in Katutura. Some very small cakes (weight less than 25gr) were sold in Outapi for N$ 0.50, and very large cakes (80-94 gr) were sold in Katutura for N$ 7.
Average price per kg:

Katutura:	N$ 97 / kg	(based on 17 measured samples from 6 sellers)
Oshakati:	N$ 52 / kg	(based on 5 measured samples from 1 seller)
Outapi:	N$ 33 / kg	(based on 5 measured samples from 1 seller)

The ***loose omboga*** is sold in big tins (148gr-278gr, average 194gr), or small tins (average 55gr in Katutura, 72gr in Oshakati). The price for a big tin is N$ 10 (only found in Katutura), and the small tin sold for N$ 2 in both Katutura and Oshakati.
Average price per kg:

Katutura:	N$ 47 / kg	(based on 9 measured samples from 4 sellers)
Oshakati:	N$ 28 / kg	(based on 10 measured samples from 1 seller)

*** Omutete** is mostly eaten by people from the Kavango and Caprivi regions and was not found in the markets in Oshakati and Outapi. It was sold loose (dried) for N$ 5 per big tin on both markets in Katutura. Average weight per tin was 166gr with little variation.
Average price per kg:
Katutura: N$ 30 / kg

*** Ekwakwa** is mostly mixed with Omboga and seldom sold in a pure form. We did however find some dried cakes at the Omatala in Oshakati. They are sold for N$ 2 or N$ 3 per cake, like omboga, but the few cakes we managed to buy were a bit lighter (34gr on average) than the Omboga cakes, therefore the average price per kg seems a bit higher:
Oshakati: N$ 66 / kg (based on 4 measured samples from 1 seller)

*** Omundjulu** is not sold at any market, as it is not eaten by itself and is always mixed with Omboga and Ekwakwa
* Two other types of IGLV that have not been part of this research were also found: ***Iihwiki*** (made from bean leaves) and ***Ekundu*** (made from Aloe, relatively popular in the Ombalantu area)
- Iihwiki was sold in Katutura for N$ 4 per (large) cake.
Average price per kg:
Katutura: N$ 43 / kg (based on 1 sample only)
- Ekundu was sold for N$ 4 per cake in Katutura and for N$ 2 per cake in Outapi.
Average price per kg:
Katutura: N$ 98 / kg (based on 2 samples from 1 seller)
Outapi: N$ 43 / kg (based on 3 samples from 1 seller)

Recipes

Selling a product that is unknown to many people requires a number of marketing tools. Providing attractive recipes can be one of the tools that can prove very useful in the case of the IGLV. The following recipes were given by the participants:

Traditional preparation:

Ombidi, mixed with Ekwakwa and a bit of Omundjulu
- cook the IGLV until smooth and soft
- add salt and cooking oil (but preferably marula oil, milk fat, or butter)
- add fresh tomatoes and onions (done in about half of the cases)
- eat with oshifima (mahangu pap)

NB When using the dries cakes, it is advisable to soak them in water first

Omutete;
- Cook the Omutete, squeeze out the juice, put the omutete in fresh water, cook again, squeeze again, and cook in fresh water (total cooking time 30-60 minutes)
- add fresh tomatoes and onions (nowadays often replaced by tomato paste or tinned fish)
- add cooking oil and a bit of salt to taste

NB Traditionally Omutete is pounded before drying, which has an effect on the taste

Variations on the traditional preparation:

Ombidi (FSA)
cook ombidi, adding onions, fresh tomatoes, tomato soup, spices, oil (and pilchards)

Omutete (MK);
- Cook the Omutete, squeeze out the juice, put the omutete in fresh water, cook again, squeeze again (total cooking time +- 30 minutes)
- fry onions and tomatoes
- add 1 teaspoon of tomato paste
- add the omutete
- add salt, spices, and soup to taste

Non-traditional dishes:

French oven dish with Ekwakwa (RG)
- About 250 to 300g just blanched Ekwakwa leaves coarsely chopped
- mix in a bowl with: one or two whole eggs, two to three table spoons of cream, some grated cheese
- add salt and pepper to taste
- put in an oven resistant dish
- a bit more of grated cheese and butter at the top
- cook in the oven for 20 to 30 minutes

Stirfry (MK)
- cut beef and fry
- add onion, tomatoes, garlic and Ombidi or Ekwakwa
- add salt, pepper and other spices to taste

Ombidi Stirfry (EK)
-Cook ombidi for 10-15 minutes, and drain the water
- fry onions in butter
- add (cooked) ombidi
- add a bit of soup, salt and white pepper

Soup (cooks of soup kitchen)
- cook ombidi and ekwakwa in a lot of water
- add soya mince and Russians sausages
- add a packet of tuna soup, salt and cooking oil

Ekwakwa camping meal (ABK)
- bring water with dried Ekwakwa to the boil, drain water when boiling
- mash Ekwakwa with a tin of sardines
- add salt, pepper, and lemon juice to taste
- eat on crackers

Ekwakwa sauce (ABK)
- mix and warm up sesame paste, peanut butter and cream

- add drained Ekwakwa
- add spices (Madagascar green pepper)
- sauce can be eaten over chicken, pasta or rice

Ombidi health mix (ABK)
- bring water with dried Ombidi and sundried tomatoes to the boil, drain water when boiling
- quarter the sundried tomatoes
- fry in olive oil the Ombidi, sundried tomatoes, onions, half-stoned black olives, and pine kernels
- eat with rice or pasta

Omutete stirfry with eggs (ABK)
- bring water with dried Omutete to the boil, drain water when boiling
- fry onions and garlic in olive oil, add tarragon (herb)
- add the Omutete and scrambles eggs

Ekwakwa with mushrooms (JC)
- fry mushrooms in olive oil
- add a bit of lemon juice
- add Ekwakwa just before dishing

Ekwakwa salad (JC)
- Mix Ekwakwa from a jar can be mixed in any salad, for example with feta cheese, lettuce, gherkins, tomatoes, olive oil and black pepper

Conclusions and recommendations

Comparison of Species

The most consumed type of IGLV in the north-central regions is Eewanda, a dried cake consisting of mostly Omboga/ombidi, mixed with some Ekwakwa, and a bit of Omundjulu. Omboga/ombidi and Ekwakwa are also eaten pure, but Omundjulu is not. In our panel test and cooking trials where the vegetables were served in pure form, Oshiwambo speaking people rated Ombidi and Ekwakwa almost equally, and people not known to the vegetables showed a slight to strong preference for Ekwakwa. When prepared in their own manner, all participants liked Ombidi and Ekwakwa, and they can therefore be considered to have the strongest market potential.

Omundjulu was generally considered not edible in its pure form, but when added to Ombidi in small quantities, it was said to improve the taste, cooking time and texture of the dish. An additional marketing problem with this species is the fact that there are two types of omundjulu; omundjulu that grows in the field and is suitable for human consumption, and another type that grows wildly and is considered as animal fodder. It was suspected that for our processing trials we had purchased the latter type, and marketing trials with this species were therefore discontinued.

Omutete has a stronger and more specific taste than Ombidi and Ekwakwa, and will need specific preparations and dishes in order to be appreciated. Its marketing potential is present, but more limited.

Comparison of conservation methods

There was a lot of variation in preference of conservation methods. On a direct comparison between blanched/dried and raw/dried Ombidi during the panel test in Outapi, the blanched/dried scored better on all variables, and it was therefore decided to continue with only the blanched/dried form during the cooking trials in Windhoek. In Windhoek people tended to opt for the dried IGLVs mainly in cases where no freezers or fridges were available, and there was a much stronger preference for either the frozen IGLV or the cooked and sterilized jars. Especially the frozen IGLVs which did not really stand out during the panel test in Outapi, were highly appreciated by the participants of the cooking trials in Windhoek, because of its convenience and fresh taste. The cooked and sterilized jars found either strong support or strong rejection. The taste was generally rated well, but some participants expressed concerns mainly about the loss of nutrients, and preservation of the quality or expiry dates. This concern was sustained when the contents of one of the jars was found rotten, and several others had a thin white layer on top of the vegetables, the origin of which is still being investigated. The Lacto-fermented vegetables were only appreciated by a few participants, and similar concerns about conservation were raised.

Suggestions for improvement

Most of the oshiwambo speaking people, even when urbanized, are used to the presence of sand in their food, and didn't complain about the sandiness of the IGLV. Although it wasn't seen as a favorable condition, most people were simply not too bothered about it. However, people from other ethnical backgrounds, and professionals in the restaurant and catering business, did complain about the sandiness of the IGLVs. For the products to successfully commercialise, they should in some ways show superiority to the traditional products that are available in informal markets, and guarantee of hygienic standards, including the absence of sand, should be one of the most important factors to concentrate on.

The quality problems or variations with the cooked and sterilized IGLVs should also be investigated and solved before any marketing of these products can take place.

Marketing Potential

From the results of the market research, several market segments can be considered and further investigated:

- Restaurants, although not all conventional restaurants would be interested in using indigenous vegetables, the more independent restaurants could be targeted to use especially frozen Ombidi and Ekwakwa, and to a lesser extent Omutete which can only be used in a few specialized dishes.
- Caterers, whether based on conventional, health food, or more traditional dishes, could be targeted to use either blanched/dried or frozen Ombidi or Ekwakwa. The taste of omutete would probably be too strong to be used on large scale food production

- Soup kitchens and orphanages, a growing sector in urban areas. Although often working with food donations, they could be very interested in working with IGLVs because of their high nutritional value, local availability, familiar taste. and easy storage. Omutete will most likely not find a market here, but dried or frozen Ekwakwa and Ombidi (depending on price and storage facilities) most definitely could.
- Middle or higher income urban consumers that are familiar with the traditional vegetables, but are either concerned about the conditions in which the IGLV are traditionally prepared and stored, or don't have time to go shopping at informal markets, or are simply curious to try out a more luxurious or modern version of the known and appreciated vegetables and are willing to pay a higher price for that. It can be expected that they will show a preference for either the frozen or bottled IGLV. Ombidi and Ekwakwa will be more popular than Omutete, simply because a larger part of the population is familiar with them as a traditional dish.
- The health food sector, a small but growing sector in Namibia targeting less conventional health conscious people through small specialized shops and markets, and larger fresh produce shops. Consumers in this sector will prefer fresh vegetables, but may be convinced to buy frozen, dried, or bottled Ekwakwa, Ombidi, or Omutete because of the high nutritional value, and the exotic image. As consumers in this sector are used to pay relatively high prices for food, the cost of the IGLV should be less of an issue.
- A small niche market could be dried Ekwakwa or Ombidi to be used while camping

It is not expected that lower income traditional urban consumers will buy any of the tested IGLVs. They are more likely to buy the traditionally prepared IGLVs, because they are affordable, readily available, known, and appreciated. Concerns regarding the traditionally prepared IGLVs like hygiene, sandiness and informal availability, will be less of an issue for this group of consumers than the price.

Marketing tools IGLV

Although a full marketing strategy should be designed and implemented at a later stage, some ideas and useful suggestions came out of this initial market research:

- General promotion of the IGLV should focus on its high nutritional values, through articles, leaflets, and/or clear information on the products.
- Promotion to larger scale consumers, like restaurants, caterers, and soup kitchens will need a more personal approach in convincing, accompanied by the handing out of samples
- Promotion to individual consumers may initially require promotion stands in supermarkets and vegetable outlets, where people can taste feel and smell the products prepared in traditional and non-traditional ways
- Promotion to urban consumers that are not familiar with the IGLVs should be accompanied by a leaflet with attractive recipes
- Promotion to urban consumers that are familiar with the IGLV should somehow show the superiority of the products compared to the traditionally prepared vegetables in nutritional value, convenience, and/or hygiene.

Recommendations for further research

Although the market research done so far has produced optimism and a lot of valuable ideas and information, there will be a need for more quantitative market surveys in the different potential market segments. This may include larger scale tasting trials at supermarkets or fresh produce stores. The size of the market will largely depend on the price of the various products, and more clarity in this regard is needed

Once quantitative data on markets and prices will be available, work should be done on designing product image and promotion strategies.

Results IGLV panel test Outapi market

TASTE

	OMBOGA			OMUTETE			EKWAKWA			MIX (omboga/ekw/omundjlulu)		
	raw, dried	blanched dried	jar, sterilised	frozen	traditional	lacto-fermented	jar, sterilised	raw, dried	frozen	traditional	jars, omb & ekwakw	blanched & frozen
cooks	6	5	7	4	5	7	6	5	7	7	5	4
R1	4	3	4	3	2	2	4	5	5	4	4	5
R2	5	5	3	3	2	2	5	5	5	7	5	4
R3	5	7	4	1	2	3	2	5	4	7	4	4
R4	3	1	6	3	3	4	5	4	6	7	6	3
R5	4	3	5	3	1	2	5	4	4	4	7	4
U1	4	7	5	3	2	2	5	3	5	7	5	3
U2	4	4	6	3	4	1	6	5	4	5	5	3
U3	1	7	5	1	1	1	7	7	1	7	1	4
U4	4	7	5	1	1	2	4	5	3	7	4	3
U5	5	4	3	5	3	3	6	4	4	7	4	5
F1	3	5	2	1	1	1	5	6	3	3	4	3
F2	3	2	1	2	2	1	5	5	4	5	3	3
F3	3	5	1	1	2	1	5	3	2	1	2	2
F4	2	4	4	1	3	4	4	3	3	4	3	5
F5	5	5	3	2	2	3	5	4	4	4	4	4
AVERAGE	**3.81**	**4.63**	**4.00**	**2.31**	**2.25**	**2.44**	**4.94**	**4.56**	**4.00**	**5.38**	**4.13**	**3.69**
	average	*good*	*average*	*very bad*	*very bad*	*very bad*	*good*	*good*	*average*	*good*	*average*	*average*
ST DEV	**1.28**	**1.82**	**1.75**	**1.25**	**1.13**	**1.59**	**1.12**	**1.09**	**1.46**	**1.89**	**1.45**	**0.87**
AV owamb	**4.09**	**4.82**	**4.82**	**2.73**	**2.36**	**2.64**	**5.00**	**4.73**	**4.36**	**6.27**	**4.55**	**3.82**
	average	*good*	*good*	*bad*	*very bad*	*bad*	*good*	*good*	*average*	*very good*	*good*	*average*
AV foreign	**3.20**	**4.20**	**2.20**	**1.40**	**2.00**	**2.00**	**4.80**	**4.20**	**3.20**	**3.40**	**3.20**	**3.40**
	bad	*average*	*very bad*	*horrible*	*very bad*	*very bad*	*good*	*average*	*bad*	*bad*	*bad*	*bad*

Results IGLV panel test Outapi market

APPEARANCE

	OMBOGA			OMUTETE			EKWAKWA			MIX (omboga/ekw/omundjlulu)		
	raw, dried	blanched dried	jar, sterilised	frozen	traditional	lacto-fermented	jar, sterilised	raw, dried	frozen	traditional	jars, omb & ekwakw	blanched & frozen
cooks	6	5	7	6	4	7	5	4	7	5	7	6
R1	4	5	3	5	2	4	5	4	5	4	5	5
R2	4	5	3	3	3	2	5	5	5	7	5	5
R3	4	7	3	2	2	3	3	5	3	7	4	4
R4	4	2	5	4	4	4	5	4	6	3	4	5
R5	5	3	6	3	2	2	5	5	6	7	7	6
U1	4	7	4	6	5	5	5	4	5	5	5	5
U2	3	4	5	2	5	4	5	3	7	7	5	1
U3	6	6	6	6	7	1	7	7	2	7	4	1
U4	4	7	4	5	1	2	4	5	3	7	4	3
U5	5	5	4	5	4	3	5	4	4	7	4	4
F1	4	5	5	3	4	5	5	6	5	4	5	6
F2	3	3	5	2	5	6	5	5	5	4	4	5
F3	5	5	6	3	3	4	4	5	4	2	4	5
F4	3	5	5	2	3	3	4	4	4	2	4	5
F5	3	4	4	3	5	5	4	4	5	4	5	4
AVERAGE	**4.19**	**4.88**	**4.69**	**3.75**	**3.69**	**3.75**	**4.75**	**4.63**	**4.75**	**5.13**	**4.75**	**4.38**
	average	*good*	*good*	*average*	*average*	*average*	*good*	*good*	*good*	*good*	*good*	*average*
ST DEV	**0.98**	**1.45**	**1.20**	**1.53**	**1.54**	**1.61**	**0.86**	**0.96**	**1.39**	**1.89**	**1.00**	**1.54**
AV owaml	**4.45**	**5.09**	**4.55**	**4.27**	**3.55**	**3.36**	**4.91**	**4.55**	**4.82**	**6.00**	**4.91**	**4.09**
	average	*good*	*good*	*average*	*average*	*bad*	*good*	*good*	*good*	*very good*	*good*	*average*
AV foreign	**3.60**	**4.40**	**5.00**	**2.60**	**4.00**	**4.60**	**4.40**	**4.80**	**4.60**	**3.20**	**4.40**	**5.00**
	average	*good*	*good*	*bad*	*average*	*good*	*average*	*good*	*good*	*bad*	*average*	*good*

Results IGLV panel test Outapi market

SMELL

	OMBOGA				OMUTETE			EKWAKWA			MIX (omboga/ekw/omundjlulu)		
	raw, dried	blanched dried	jar, sterilised	frozen	traditional	lacto-fermented	jar, sterilised	raw, dried	frozen	traditional	jars, omb & ekwakw	blanched & frozen
cooks	5	4	6	6	4	7	7	5	6	7	6	5
R1	5	4	3	4	3	4	4	4	5	4	5	5
R2	3	5	3	3	3	4	5	5	5	7	5	5
R3	5	7	4	3	2	3	3	5	3	7	5	3
R4	5	4	4	3	3	4	4	5	4	6	4	4
R5	5	5	6	3	4	4	4	5	5	4	7	4
U1	4	4	6	3	2	2	4	4	4	7	5	4
U2	3	4	2	3	2	6	5	6	4	7	5	3
U3	4	7	5	6	2	1	7	7	2	7	1	6
U4	5	7	5	3	1	2	4	5	3	7	4	3
U5	5	4	4	5	3	3	6	4	3	7	5	4
F1	4	5	4	4	5	3	6	5	4	6	4	4
F2	4	4	4	4	4	4	4	4	4	4	4	4
F3	5	5	2	5	5	4	5	5	3	3	5	3
F4	2	4	4	4	4	3	4	2	2	3	4	4
F5	4	5	4	3	4	4	4	3	3	3	4	5
AVERAGE	**4.25**	**4.88**	**4.13**	**3.88**	**3.19**	**3.63**	**4.75**	**4.63**	**3.75**	**5.56**	**4.56**	**4.13**
	average	*good*	*average*	*average*	*bad*	*average*	*good*	*good*	*average*	*very good*	*good*	*average*
ST DEV	**0.93**	**1.15**	**1.26**	**1.09**	**1.17**	**1.45**	**1.18**	**1.15**	**1.13**	**1.71**	**1.26**	**0.89**
AV owamb	**4.45**	**5.00**	**4.36**	**3.82**	**2.64**	**3.64**	**4.82**	**5.00**	**4.00**	**6.36**	**4.73**	**4.18**
	average	*good*	*average*	*average*	*bad*	*average*	*good*	*good*	*average*	*very good*	*good*	*average*
AV foreign	**3.80**	**4.60**	**3.60**	**4.00**	**4.40**	**3.60**	**4.60**	**3.80**	**3.20**	**3.80**	**4.20**	**4.00**
	average	*good*	*average*	*good*	*average*	*average*	*good*	*average*	*bad*	*average*	*average*	*average*

Results IGLV panel test Outapi market

TEXTURE

	OMBOGA				OMUTETE			EKWAKWA			MIX (omboga/ekw/omundjlulu)		
	raw, dried	blanched dried	jar, sterilised	frozen	traditional	lacto-fermented	jar, sterilised	raw, dried	frozen	traditional	jars, omb & ekwakw	blanched & frozen
cooks	6	7	5	5	4	6	7	4	5	5	7	7
R1	2	3	3	3	2	3	4	3	6	3	5	5
R2	4	4	5	5	3	5	4	5	5	7	4	5
R3	4	7	5	4	2	3	3	6	3	7	3	3
R4	4	6	4	7	6	5	6	5	6	7	5	6
R5	5	6	4	3	4	1	5	4	5	5	5	5
U1	4	7	5	6	5	5	4	5	4	6	5	6
U2	3	4	6	2	1	7	6	5	4	7	7	2
U3	7	4	4	6	6	1	3	2	1	7	6	1
U4	4	7	6	2	1	2	3	5	3	7	4	3
U5	5	4	3	5	3	4	6	4	4	7	4	4
F1	4	5	3	1	2	2	3	3	3	3	4	3
F2	4	4	5	2	4	4	5	5	5	4	4	4
F3	5	5	3	4	4	3	4	4	4	1	4	3
F4	4	5	5	4	4	4	5	5	5	4	5	5
F5	4	4	4	3	4	4	5	4	4	5	4	4
AVERAGE	**4.31**	**5.13**	**4.38**	**3.88**	**3.44**	**3.69**	**4.56**	**4.31**	**4.19**	**5.31**	**4.75**	**4.13**
	average	*good*	*average*	*average*	*bad*	*average*	*good*	*average*	*average*	*good*	*good*	*average*
ST DEV	**1.14**	**1.36**	**1.02**	**1.71**	**1.55**	**1.70**	**1.26**	**1.01**	**1.28**	**1.89**	**1.13**	**1.59**
AV owambo	**4.36**	**5.36**	**4.55**	**4.36**	**3.36**	**3.82**	**4.64**	**4.36**	**4.18**	**6.18**	**5.00**	**4.27**
	average	*good*	*good*	*average*	*bad*	*average*	*good*	*average*	*average*	*very good*	*good*	*average*
AV foreign	**4.20**	**4.60**	**4.00**	**2.80**	**3.60**	**3.40**	**4.40**	**4.20**	**4.20**	**3.40**	**4.20**	**3.80**
	average	*good*	*average*	*bad*	*average*	*bad*	*average*	*average*	*average*	*bad*	*average*	*average*

Results IGLV panel test Outapi market

GENERAL PREFERENCE (per IGLV type)

	OMBOGA			OMUTETE			EKWAKWA			MIX (omboga/ekw/omundjlulu)		
	raw, dried	blanched dried	jar, sterilised	frozen	traditional	lacto-fermented	jar, sterilised	raw, dried	frozen	traditional	jars, omb & ekwakw	blanched & frozen
cooks			x			x	x		x	x		
R1									x			x
R2		x							x	x		
R3		x						x		x		
R4			x			x			x	x		
R5	x						x				x	
U1		x		x					x	x		
U2			x			x	x					x
U3		x					x			x		
U4		x						x		x		
U5	x			x			x			x		
F1		x			x			x			x	
F2	x			x				x		x		
F3		x			x		x				x	
F4			x			x	x					x
F5		x				x	x			x		
	3 x	8 x	4 x	3 x	2 x	5 x	8 x	4 x	5 x	10 x	3 x	3 x

IGLV panel test Outapi market

Particulars of respondents

	R/U/F	gender	age	etnicity	occupation
R1	rural	F	23	Ombalantu	market woman
R2	rural	F	42	Okwambi	market woman
R3	rural	F	18	Ombalantu	market woman
R4	rural	M	25	Ombalantu	tailor
R5	rural	F	32	Ombalantu	market woman
U1	urban	M	47	Ombalantu	town clerk
U2	urban	F	32	Ombalantu	market woman
U3	urban	F	30	Ombalantu	town planner
U4	urban	F	34	Ombalantu	market woman
U5	urban	M	20	Uukwaluudhi	tailor
F1	foreigner	F	24	Swiss	volunteer
F2	foreigner	F	27	Finnish	volunteer
F3	foreigner	F	26	Finnish	volunteer
F4	foreigner	F	33	Sri Lanka	volunteer
F5	foreigner	M	39	Sri Lanka	program officer

Questionnaire panel testers

Name: ……..
Gender: [ ] female [ ] male
Age: …..
Etnicity: ……..
Occupation: ……..
Rural / urban / foreigner

1. Do you eat any of the following vegetables:

Omboga (mixed with ekwakwa / omundjulu) [ ] yes
[ ] no, because……
…

Omboga (pure, not mixed) [ ] yes
[ ] no, because ……
…

Ekwakwa (pure, not mixed) [ ] yes
[ ] no, because ……
……

Omutete [ ] yes
[ ] no, because……
…

Iihwiki [ ] yes
[ ] no, because ……
…

Ekundu [ ] yes
[ ] no, because ……
……

2. Which one do you like best? ……

3. How often do you eat them?

[ ] more than once per week
[ ] once per week
[ ] once per month
[ ] seldomly

4. Do you eat them throughout the year or only in a particular season

[ ] throughout the year

[ ] only when they are available from ……till…….
[ ] only when there is nothing else to eat (from ……. till ……)

5. Where do you get these vegetables?

[ ] mostly get them from my own field
[ ] mostly get / buy them from relatives or friends
[ ] mostly buy them at the market

6. Do you sell omahanda?

[ ] yes
[ ] no

If yes:

Where do you sell them? ……
How much do you sell? …….
From where do you get them? ……

7. How long does it take to cook omahanda? ……..

8. What is your favorite recipe, using omboga, Ekwakwa, Omutete, and/or Omundjulu?

(describe which vegetables are used, how long they are cooked, what ingredients are added and any other particulars)

……
……
……
……
……
……
……
……
……
……
……
……
……

Dapandula Unene !!

Open interviews
Individuals

Which processing type did you like to cook and why (and least).
- frozen
- lacto fermented
- cooked and pasteurized
- dried

Which type of IGLV did you like the most and why (and least)

Would you buy any of these products if they were available in the supermarket?

-Which type?

-At what price?

How would you compare the IGLV to conventional spinach?

Could /would you replace the conventional spinach with IGLV in your dishes?

Do you think there is a substantial market for IGLV in urban Namibia? What market segment / who would buy and for what purpose?

Recipees: how did you prepare the IGLV?

Open interviews
Restaurants, Caterers, and Soup kitchen

Which processing type did you like to work mostly with and why (and least). Which type is most convenient and appropriate for cooking in your business?

Which type of IGLV did you like the most and why (and least)

Would you buy any of these products if they were available?

-Which type?

-At what price?

How would you compare the IGLV to conventional spinach?

Could you replace the conventional spinach with IGLV in your dishes?

Recipes: Hw did you prepare the IGLV?

Panel testing: Omboga

Name: ……

1	2	3	4	5	6	7
horrible	very bad	bad	average	good	very good	excellent

BLUE plate:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
texture	1	2	3	4	5	6	7	
General description								

RED plate:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
texture	1	2	3	4	5	6	7	
General description								

GREEN plate:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
texture	1	2	3	4	5	6	7	
General description								

Which of the 3 plates do you like best? [ ] BLUE plate [ ] RED plate [ ] GREEN plate

Why? ……
……..

Omutete

Rate according to the following numbers:

1	2	3	4	5	6	7
horrible	very bad	bad	average	good	very good	excellent

Frozen:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
Texture	1	2	3	4	5	6	7	
General description								

Cooked and sterilised:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
Texture	1	2	3	4	5	6	7	
General description								

Dried, blanched:

	ranking							Comments
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
Texture	1	2	3	4	5	6	7	
General description								

Lacto-fermented:

	ranking	Comments

Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
Texture	1	2	3	4	5	6	7	
General description								

Traditional:

	ranking							**Comments**
Appearance	1	2	3	4	5	6	7	
Smell	1	2	3	4	5	6	7	
Taste	1	2	3	4	5	6	7	
Texture	1	2	3	4	5	6	7	
General description								

How was the Omutete prepared?

Which type was nice to cook? Why?

Which one was nice to eat? Why?

Would you buy any of these if they were available in the supermarket?

If yes, which type, and why?

What price would you be willing to pay for it?

APPENDIX E
LABORATORY REPORTS

ANALYTICAL LABORATORY SERVICES

P.O. Box 2108, Windhoek, Namibia
Tel (061) 210132 Fax (061) 210058 email analab@mweb.com.na

TEST REPORT

To: CRIAA SA DC
P.O. Box 23778
Windhoek
criaawhk@iafrica.com

Date received: 13-Apr-05
Date required:
Date completed: 23-May-05

Attention: Pierre

Your Reference: verbal
Lab. Reference: I050249

Type of Sample(s)
Indigenous green leavy vegetables

Samples Received

Four samples received on 13/04/2005

Test(s) Required
Moisture content, protein content, ash content, Vitamin C, calcium, iron, phosphorus

Test Method(s) used
The determination of moisture (Ref. Official and Standardized Methods of Analysis, 1994,
3rd edition, edited by Colin Watson)
Dried to constant weight at ±100°C/±2h
Reporting: Weight % (m/m)

Determination of nitrogen (Ref. Official and Standardized Methods of Analysis, 1994,
3rd edition, edited by Colin Watson)
Digestion: concentrated sulphuric acid/1.5h, selenium tablets
Distillation
Titration with 0.100M hydrochloric acid

Determination of protein (Ref. Official Methods of Analysis for the AOAC, 1970,
11th edition, Horwitz, W.)
Calculated from nitrogen content
Reporting: Weight % (m/m) wet weight basis

Determination of ash (Ref. Official Methods of Analysis for the AOAC, 1970,
11th edition, Horwitz, W.)
Ashed to 550°C to constant weight
Reporting: Weight % (m/m) wet weight basis

Determination of calcium, iron, phosphorus (Ref. Official Methods of Analysis for the AOAC, 1970,
11th edition, Horwitz, W.)
Ash dissolved in hydrochloric acid

Calcium, iron determined by ICP
Phosphorous determined colorimetrically
Reporting: mg/100g wet weight basis

Determination of Ascorbic acid (Ref. Lebensmittel Analytik Grundzüge-Methoden-Anwendung,2nd
edition, 1992, Springer Verlag, Berlin)Redox titration with 2,6-dichlorophenolindophenol (Tillmans)
Stabilising agent: 2% oxalic acid
Reporting: mg/100g wet weight basis

Results

Test Identification	Moisture Weight %	Protein Weight % (wet)	Ash Weight % (wet)	Vitamin C mg/100g (wet)
1. *Cleome gynandra*	80.6	4.7	4.0	96.6
2. *Amaranthus thunbergia*	82.7	4.9	3.3	71.3
3. *Hibiscus sabdariffa*	84.9	4.2	1.1	6.5
4. *Sesuvium* spp.	91.9	2.3	1.5	3.0

Test Identification	Calcium mg/100g (wet)	Iron mg/100g (wet)	Phosphorus as P mg/100g (wet)
1. *Cleome gynandra*	372	6.5	62.6
2. *Amarnthus thunbergia*	327	2.7	77.4
3. *Hibiscus sabdariffa*	165	1.5	64.9
4. *Sesuvium* spp.	15.6	1.0	31.6

Remark:

Ranking of species considering nutritional composition
Mineral content: Cleome>Amaranthus>Sesuvium>Hibiscus
Protein content: Cleome, Amaranthus>Hibiscus>Sesuvium
Vitamin C content: Cleome>Amaranthus>Hibiscus>Sesuvium
Phosphorus content: Amaranthus>Cleome>Hibiscus>Sesuvium
Iron content: Cleome>Amaranthus>Hibiscus>Sesuvium
Calcium content: Cleome>Amaranthus>Hibiscus>Sesuvium

S. Rügheimer
Section Head: Microbiology & Food Chemistry

ANALYTICAL LABORATORY SERVICES

P.O. Box 2108, Windhoek, Namibia
Tel (061) 210132 Fax (061) 210058 email analab@mweb.com.na

TEST REPORT

To: CRIAA SA DC
P.O. Box 23778
Windhoek
criaawhk@iafrica.com

Date received: 06-July-05
Date required:
Date completed: 20-July-05

Attention: Pierre
verbal

Your Reference:

Lab. Reference: I050384

Type of Sample(s)
Indigenous green leavy vegetables, processed

Samples Received

Six samples received on 06/07/2005

Test(s) Required
Moisture content, protein content, ash content, Vitamin C, calcium, iron, phosphorus

Test Method(s) used
The determination of moisture (Ref. Official and Standardized Methods of Analysis, 1994,
3rd edition, edited by Colin Watson)
Dried to constant weight at ±100°C/±2h
Reporting: Weight % (m/m)

Determination of nitrogen (Ref. Official and Standardized Methods of Analysis, 1994, 3rd edition, edited by Colin Watson)
Digestion: concentrated sulphuric acid/1.5h, selenium tablets
Distillation
Titration with 0.100M hydrochloric acid

Determination of protein (Ref. Official Methods of Analysis for the AOAC, 1970, 11th edition, Horwitz, W.)
Calculated from nitrogen content
Reporting: Weight % (m/m) wet weight basis

Determination of ash (Ref. Official Methods of Analysis for the AOAC, 1970, 11th edition, Horwitz, W.)
Ashed to 550°C to constant weight
Reporting: Weight % (m/m) wet weight basis

Determination of calcium, iron, phosphorus (Ref. Official Methods of Analysis for the AOAC, 1970,
11th edition, Horwitz, W.)
Ash dissolved in hydrochloric acid
Calcium, iron determined by ICP
Phosphorous determined colorimetrically

Reporting: mg/100g wet weight basis

Determination of Ascorbic acid (Ref. Lebensmittel Analytik Grundzüge-Methoden-Anwendungen, 2nd edition, 1992, Springer Verlag, Berlin)
Redox titration with 2,6-dichlorophenolindophenol (Tillmans)
Stabilising agent: 2% oxalic acid
Reporting: mg/100g wet weight basis

Results

Test Identification	Moisture Weight %	Protein Weight % (wet)	Ash Weight % (wet)	Vitamin C mg/100g (wet)
1. *Cleome* + little *Amaranthus*, (9) blanche, vacuum, pasteur, cool	87.9	4.3	1.4	3.0
2. *Cleome*, (5) microwave	90.7	3.0	1.3	0.6
3. *Amaranthus*, blanche, 19/04/05	89.7	3.1	1.8	0.6
4. *Amaranthus*, (38) microwave	87.5	3.8	2.1	6.7
5. *Hibiscus*, (41) blanche	88.0	2.2	0.6	11
6. *Hibiscus*, (53?) microwave	85.6	3.3	0.9	33

Test Identification	Calcium mg/100g (wet)	Iron mg/100g (wet)	Phosphorus as P mg/100g (wet)
1. *Cleome* + little *Amaranthus*, (9) blanche, vacuum, pasteur, cool	195	2.7	74
2. *Cleome*, (5) microwave	124	2.5	48
3. *Amaranthus*, blanche, 19/04/05	205	1.9	47
4. *Amaranthus*, (38) microwave	202	2.3	54
5. *Hibiscus*, (41) blanche	97	1.4	27
6. *Hibiscus*, (53?) microwave	102	2.5	31

Remark:
Leakage from blanched vegetables contained considerable more Vitamin C compared the leakage from microwave treated samples.

Comparison of processed samples vs original (raw) samples (considering samples 2-6)
Increase in moisture content: 0.9-13%
Decrease in ash content: 13-67%
Decrease in protein content: 21-47%
Decrease in phosphorus content: 23-59%
Decrease in calcium content: 38-67%
Decrease in iron content (except for no. 6; contamination?): 11-58%
Significant decrease in Vitamin C content (except for no. 5 and 6; interference redox active species?): 91-99%

Comparison of blanched vs microwave treated samples (considering samples 3, 4 and 5, 6)
Less moisture taken up during mw compared to bl
Less minerals lost during mw compared to bl
Less proteins lost during mw compared to bl
Slightly less phosphorus lost during mw compared to bl
Calcium, no significant difference between treatments
Slightly less iron lost during mw compared to bl (considering only samples 3 and 4)
Slightly less Vitamin C lost during mw compared to bl (considering only samples 3 and 4)

Comparison of species that were microwave treated (considering samples 2 *Cleome*, 4 *Amaranthus* and 6 *Hibiscus*)
Moisture gained: 2 (13%) >4 (5.8%) >6 (0.9%)
Minerals lost: 2 (67%) >4 (36%) >6 (13%)
Proteins lost: 2 (36%) >4 (21%), 6 (21%)
Phosphorus lost: 6 (52%) >4 (30%) >2 (23%)
Calcium lost: 2 (67%) >4 (38%), 6 (38%)
Iron lost: 2 (58%) >4 (16%) (sample 6 not considered)

Vitamin C lost: 2 (99%) >4 (91%) (sample 6 not considered)

Ranking of species considering nutritional composition after microwave treatment
Mineral content: Amaranthus>Cleome>Hibiscus
Protein content: Cleome, Amaranthus>Hibiscus
Vitamin C content: Amaranthus>Cleome
Phosphorus content: Amaranthus>Cleome>Hibiscus
Iron content: Cleome, Amaranthus
Calcium content: Amaranthus>Cleome>Hibiscus

_____
S. Rügheimer, Section Head: Microbiology & Food Chemistry

ANALYTICAL LABORATORY SERVICES

P.O. Box 2108, Windhoek, Namibia
Tel (061) 210132 Fax (061) 217102 email analab@mweb.com.na

TEST REPORT

To: CRIAA SA DC
P.O. Box 23778
Windhoek
Fax

Date received: 06-July-05
Date required:
Date completed: 16-July-05

Attention: Roger

Your Reference: **verbal**
Lab. Reference: **I050384**

Type of Sample(s)
Green leavy vegetables, processed

Samples Received

One sample received on the 06/07/2005 and tested on the 07/07/2005

Test(s) Required
Viable clostridial spores and/or vegetative cells
Total colony count

Test Method(s) used
SABS method 761 Examination for the presence of viable spores of mesophilic clostridium organisms in foods
Enrichment in differential reinforced broth with polymyxin B, 37°C, 120h
Reinforced clostridial agar with egg yolk, aerobically and anaerobically, 37°C, 48h
Catalase reaction
Gram stain and microscopic identification

Methods for the microbiological examination of foods (American Public Health Association)
Enumeration of aerobic mesophilic organisms in foods
CFU/g
Spread plate method
Plate count agar, 35°C/48h

Duration of Test(s)
07/07/2005-16/07/2005

Result

Test Sample I.D.	Viable clostridial spores and/or vegetative cells Presence/Absence	Total colony count Cfu/g
1. EKW 500g, blanched 90, vacuum packed, Pasteur. 2', cooled, 11/04/2005	Absent	>50 000 000

Cfu = colony forming units

Remark
Following bacteria were present:
Gram positive cocci

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S. Rügheimer
Section Head: Microbiology and Food Chemistry