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The potential of South African plants in the development of new food and beverage products

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Abstract

A review is presented of the history and recent trends in the exploration and development of food plants in southern Africa. The opportunities for developing new crops and new products for local and international markets are discussed. More than 120 species with potential as new food and beverage products (including functional foods, herbal teas and new flavours) are listed and a subjective rating of the commercial potential is provided for each of them. Some noteworthy examples are discussed and illustrated, including several indigenous fruits and vegetables that are as yet poorly known. There is a growing awareness of the importance of indigenous plants in new product development and numerous new products are already being developed. Basic research in botany (to guide genotype selection), horticulture (to develop new crops), food science (to focus on nutritional analyses) and marketing (to understand and develop new marketing approaches) is mentioned as important priorities.

Keywords: Beverages; Botanical diversity; Commercial potential; Food plants; Fruit flavours; Health foods; New products; Research and development

1. Introduction

The systematic documentation and commercial exploration of edible plants in South Africa started in 1685, when the Dutch governor Simon van der Stel undertook a long journey to Namaqualand and recorded (with botanical illustrations) several food plant species used for their nutritional value and/or as a source of moisture. Well-known examples include *Cyanella hyacinthoides* L. (*chabi*, p. 786), *Chamarea capensis* (Thunb.) Eckl. & Zeyh. (*gammare*, p. 812), *Fockea angustifolia* K. Schum. (*camarebi*, *camao*, p. 826), *Cyphia digitata* (Thunb.) Willd. (*berroe*, p. 832) and *Muraltia spinosa* (L.) F.Forest. & J. C.Manning (*cargoe*, p. 866) (Van der Stel, 1685). Thunberg recorded a few species of food plants during his travels between 1772 and 1775 (Forbes, 1986), including the use of *Hydnora africana* Thunb. (*kanni* or *jakkalskos*) as food item in the Agter-Hantam, where it is still regularly eaten (De Beer and Van Wyk, 2011). The *Flora of South Africa* published in six volumes by Marloth (1913–1932) also included information about indigenous food plants. The most complete account of the edible plants of southern Africa is that of Fox and Norwood Young (1982) entitled "Food from the Veld". Namibian useful plants were reviewed by Von Koenen (1996, 2001). A recent publication on useful plants that contributed to a general interest in ethnobotany and edible plants is "People's Plants: A guide to useful plants of southern Africa" (Van Wyk and Gericke, 2000). This is the only available ethnobotanical handbook for southern Africa and covers a wide range of plant uses (including food, beverages, medicine, cosmetics and various arts and crafts). The following sentiment was expressed on the back page: "Both authors passionately believe that there has to be a concerted effort to develop novel products of exceptional quality from selected "people's plants" for regional and global markets. They want to encourage a new breed of eco-entrepreneurs to harness the synergies between indigenous knowledge systems, scientific research, and modern technologies to drive sustainable development in the southern African region for the benefit of all its peoples."

The aim of this paper is to highlight the diversity of indigenous food plants and potential new crops that are available and to evaluate the progress that has been made in economic botany in South Africa, with emphasis on the development of indigenous food

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products, including fruits, vegetables, herbal teas, alcoholic beverages, flavours and spices.

2. The diversity of potentially useful food plants in South Africa

Africa has made a very substantial contribution to the major food crops of the world, not only in the total number of species used in international trade but also in the importance of the products. Coffee (*Coffea arabica* L.) is arguably one of the most valuable of all commodities, with an annual production close to 7 million tons (http://www.fao.org). Other examples of major commodities include sorghum [*Sorghum bicolor* (L.) Moench] and West African oil palm (*Elaeis guineensis* Jacq.). Peters et al. (1992) recorded 2155 African species used as food, representing 4.3% of the African flora. A similar statistic can be calculated for southern Africa: Fox and Norwood Young (1982) described 1002 southern African food plants, which represents 4.4% of the southern African flora. The global review of commercialised food plants by Van Wyk (2005) showed that Africa has made a substantial contribution, with 119 species. This compares favourably with estimates of 126 for Europe, 68 for Central America and 97 for South America. Of the 119 commercialised African products, 16 are derived from plants indigenous to southern Africa: gum Arabic [*Acacia senegal* (L.) Willd.], baobab [*Adansonia digitata* L.], buchu [*Agathosma betulina* (P.J.Bergius) Pillans], *waterblommetjie* [*Aponogeton distachyos* L.f], rooibos tea [*Aspalathus linearis* (Burm.f.) R.Dahlgren], sour fig [*Carpobrotus edulis* (L.) L.Bolus], jelly melon [*Cucumis metuliferus* E.Mey. ex Naudin], honeybush tea [*Cyclopia genistoides* (L.) R.Br. and related species], finger millet [*Eleusine coracana* (L.) Gaertn.], palm wine [*Hyphaene coriacea* Gaertn.], pearl millet [*Pennisetum glaucum* (L.) R.Br.], Livingstone potato [*Plectranthus esculentus* N.E.Br.], marula [*Sclerocarya birrea*(A.Rich.) Hochst.], sorghum [*Sorghum bicolor* (L.) Moench], jugo bean [*Vigna subterranea* (L.) Verdc.] and cowpea [*Vigna unguiculata*(L.) Walp.].

A list of indigenous South African species with potential for the development of new food products (including beverages, flavours, spices and others) is presented in Table 1 (author citations are not repeated in the text from here on). At least 120 indigenous South African species are available for new crop and new product development. Various naturalised exotics have also become important sources of fruits and vegetables (especially leaves, cooked as *morogo*) but these were not included in Table 1.

3. Indigenous species with commercial potential

3.1. Cereals, seeds and nuts

Indigenous cereals have largely been replaced by exotics such as maize, wheat, barley and oats, but sorghum (*Sorghum bicolor*), finger millet (*Eleusine coracana*) and pearl millet (*Pennisetum glaucum*) may have potential for developing and commercialising traditional food items based on the grains or the malt. All three these species are still popular for producing traditional malted beer because of the sweetness of their malt; malted beer is a daily food item in traditional societies (Quin, 1959) and sorghum beer (*umqombothi*, also known as traditional African beer, continues to be important, even in urban areas. According to a 2004 survey, sorghum beer consumption represented 23.6% of all commercial alcoholic beverages consumed in South Africa, compared to 42.6% for malt beer and 17.4% for wine (Sorghum Section 7 Committee, 2007). The indigenous cereals also provide food security to small-scale farmers because they are tolerant of poor soil and drought. It may be possible to encourage the production of malted beers (such as *bjalwa bja leotsa*—Quin, 1959) and traditional food items for speciality restaurants, so that tourists can experience the unique culinary traditions of the various regions of South Africa (Fox, 1938; Ashton, 1939; Quin, 1959; Rose and Jacot Guillarmod, 1974; Coetzee, 1982; Fox and Norwood Young, 1982; Coetzee and Miros, 2009). Sorghum, for example, can be used for unleavened or leavened bread, gruel, boiled whole grain or porridge made from malted "*mabele*" (well known as "*maltebele*" in South Africa). An important light-weight staple food was once made from popped pearl millet for soldiers on the move and later for mine-workers migrating over long distances (Credo Mutwa, personal communication).

Seeds, nuts and pulses are very important food items and there is undoubtedly considerable scope for the development of new crops and new products, especially in the lucrative health food and snack food markets. Seeds and nuts are not only of historical interest in southern Africa but are also of considerable interest as potential new crops for dry regions (Bostid, 1979; Arnold et al., 1985). Well-known examples include manketti nuts (*Schinziophyton rautanenii*), marula nuts (*Sclerocarya birrea*), marama beans (*Tylosema esculenta*) and baobab (*Adansonia digitata*). Manketti nuts have been a staple food in the Kalahari for at least 7000 years (Robbins and Campbell, 1990). The fruits are also popular because they can be stored in the dry state for several months (Lee, 1973; Peters, 1987). There are two closely related species of *Tylosema* in southern Africa (Coetzer and Ross, 1977), namely *T. fassoglense*, and *T. esculenta* but only the latter (marama bean) has thus far received attention from researchers. Experiments have shown that the marama bean is a potentially valuable new crop for arid regions (Bostid, 1979; Keegan and Van Staden, 1981; Powell, 1987; Monaghan and Halloran, 1996). The large seeds are not eaten raw but are delicious when roasted. They are highly nutritious, with a protein content of 30–35% and an oil content of 35–42% (Wehmeyer et al., 1969; Bower et al., 1988). The seeds (nuts) and dry fruit pulp of baobab are nowadays available from wild-crafted sources and are included in novelty food items (Figs. 2 and 1A–C)—see updated review by Viljoen, 2011a-this issue. Most seeds are also a source of valuable seed oils that have both culinary and cosmetic uses. An exception is the jugo bean (*Vigna subterranea*) that is grown only as a highly nutritious food item (Figs. 2 and 4A,B). It is considered to be one of the most under-estimated crop plants of Africa—yields of about 1000 kg/ha can be expected (Gibbon and Pain, 1985). The ripe beans are very nutritious, with 15% protein and 6% fat (Venter and Coertze, 1996) and have great potential as a new commercial snack food. There are many traditional recipes for preparing dishes from the cooked, pounded or crushed beans (Junod, 1913, 1962; Quin, 1959). The related cowpea (*Vigna*

Table 1
Indigenous South African food plants of historic, current or potential value in new crop and new product development. Species already commercialised are shown in bold. (Subjective importance rating: +++ = high, ++ = average, + = low or none).

Species; family; common name(s) (partially or fully commercialized species are indicated in bold)	**Food use(s):** (ro)ot (incl. rhizome, tuber or bulb); (st)em; (le)af; (fl)ower; (fr)uit; (se)ed; (ex)udate; (es)sential oil; (oil); (ed)ible oil/seed oil/fixed oil
Acacia karroo Hayne; Fabaceae; sweet thorn	ex++ (edible gum; sweets)
Adansonia digitata L.; Bombacaceae; baobab	se+++ (nuts); se(dried pulp)+++(health drinks, anti-oxidant)
Agathosma betulina (P.J.Bergius) Pillans; Rutaceae; round leaf buchu	le+++, es+++ (flavourant; sweets; tonic drinks)
Agathosma crenulata (L.) Pillans; Rutaceae; oval leaf buchu	le++, es++ (flavourant; sweets; tonic drinks)
Allium dregeanum Kunth; Alliaceae; *wildeprei*, wild onion	st and le+++ (vegetable, culinary herb)
Aloe arborescens Mill.; Asphodelaceae; kranz aloe, Japan aloe	leaf gel+++ (health drinks)
Aloe ferox Mill.; Asphodelaceae; bitter aloe; Cape aloe	leaf gel+++ (health drinks, jam)
Aloe marlothii A.Berger; *Asphodelaceae;* mountain aloe (Natal aloes)	leaf gel+++ (topical uses, health drinks)
***Amaranthus* hybridus** L. (and several other spp.); Amaranthaceae; *marog*	le+++ (vegetable)
Ancylobotrys capensis (Oliv.) Pichon (and other spp.); Apocynaceae; wild apricot	fr++ (fresh or dried fruit, jam, juice)
Annesorhiza nuda (Aiton) B.L.Burtt (and other spp.); Apiaceae; (mountain) anise root	ro++ (vegetable)
Annona senegalensis Pers.; Annonaceae; wild custard apple	fr+++ (fresh or dried fruit, jam, juice)
Aponogeton distachyos L.f.; Aponogetonaceae; *waterblommetjie*, pondweed	fl and young fr+++ (vegetable)
Aspalathus linearis (Burm.f.) R.Dahlgren; Fabaceae; rooibos tea	st and le+++ (tea, ice tea, health drinks; food flavourant; food dye)
Aspalathus pendula R.Dahlgren; Fabaceae; golden tea	st and le++ (tea, ice tea, health drinks)
Asparagus laricinus Burch. (and other spp.); Asparagaceae; wild asparagus, *katdoring*	young st+++ (vegetable)
Athrixia phylicoides DC.; Asteraceae; bush tea, Zulu tea	st and le+++ (tea, ice tea, health drinks)
Azanza garckeana (F.Hoffm.) Exell & Hillc.; Malvaceae; snot apple	fr++ (jam, processed products)
Berchemia discolor (Klotzsch) Hemsl.; Rhamnaceae; brown ivory	fr++ (fresh or dried fruit, jam, juice, wine, sweets)
Berchemia zeyheri (Sond.) Grubov; Rhamnaceae; red ivory	fr++ (fresh or dried fruit, jam, juice, sweets)
Bridelia micrantha Baill.; Euphorbiaceae; mitzeeri	fr++ (fresh or dried fruit, jam, juice)
Bridelia mollis Hutch.; Euphorbiaceae; velvet sweetberry	fr++ (fresh or dried fruit, jam, juice)
Bulbine frutescens (L.) Willd.; Asphodeaceae; *ibhucu*	fresh le+++ (vegetable); leaf gel+++ (health drinks)
Carissa macrocarpa (Eckl.) A.DC.; Apocynaceae; *amatungulu*	fr+++ (fresh or dried fruit, jam, juice)
Carpanthea pomeridiana (L.) N.E.Br.; Aizoaceae; *vetkousie*	le+++ (vegetable)
Carpobrotus edulis (L.) L.Bolus (and other spp.); Aizoaceae; common sour fig	fr(dry)+++ (jam, chutney; dried, processed products)
Centella asiatica (L.) Urb.; Apiaceae; pennywort	le++ (vegetable)
Chamarea capensis (Thunb.) Eckl. & Zeyh. (and other spp.); Apiaceae; *vinkelwortel*, *chamare*	ro (fresh)+++(vegetable)
Chrysanthemoides monilifera—see *Osteospermum moniliferum*	fr+++ (jam, dried, processed products; sweets; flavourant?)
Citrillus lanatus (Thunb.) Matsum. & Nakai; Cucurbitaceae; tsamma melon	fr+++ (jam, juice, processed products); se+++ (nuts, roasted and processed products)
Cleome gynandra L., *C. monophylla* L.; Capparaceae; African cabbage	le+++ (vegetable)
Conicosia pugioniformis (L.) N.E.Br.; Aizoaceae; *duikerwortel*	ro++ (vegetable; sweets?); young fr++ (vegetable)
Corchorus tridens L. (and other spp.); Tiliaceae; *ligusha*, *delele*	le+++ (vegetable)
Cucumis metuliferus E.Mey. ex Naudin; Cucurbitaceae; jelly melon	fr+++ (vegetable)
Cucumis zeyheri Sond.; Cucurbitaceae; wild cucumber	fr++ (jam; non-bitter type); le++ (vegetable)
Cyanella hyacinthoides L.; Tecophilaeaceae; *raapuintjie*	ro++ (vegetable; roasted, boiled in milk)
Cyclopia genistoides (L.) R.Br. (and other spp.); Fabaceae; honeybush tea	st and le+++ (tea, ice tea, health drinks; food flavourant; food dye)
Cyperus fulgens C.B.Clarke; Cyperaceae; nutsedge, *boesmanuintjie*	ro+++ (vegetable; roasted, boiled in milk; health drinks, made in the same way as "*horchata de chufa*"?)
Diospyros mespiliformis Hochst. ex A.DC.; Ebenaceae; jackal-berry	fr+++ (jam, dried, wine, sweets, processed products)
Diospyros ramulosa (E.Mey. ex A.DC.) De Winter; Ebenaceae; *koenoekam*	fr+++ (jam, dried, wine, sweets, processed products)
Dovyalis caffra (Hook.f. & Harv.) Hook.f.; Salicaceae; Kei-apple	fr+++ (jelly, jam, dried, liqueurs, sweets, processed products)
Dovyalis rhamnoides (Burch. ex DC.); Salicaceae; common sourberry	fr++ (jelly, jam, dried, liqueurs, processed products)
Dovyalis zeyheri (Sond.) Warb.; Salicaceae; wild apricot	fr++ (jelly, jam, dried, liqueurs, processed products)
Eleusine coracana (L.) Gaertn.; Poaceae; African finger millet	fr+++ (health foods, breakfast cereals, popcorn?)
Englerophytum magalismontanum (Sond.) T.D.Penn.; Sapotaceae; Transvaal milkplum, *stamvrug*	fr+++ (fresh or dried fruit, jam, jelly, wine, juice?)
Ficus sur Forssk.; Moraceae; Cape fig	fr+ (jam, dried, processed products)
Ficus sycomorus L.; Moraceae; sycamore fig	fr+++ (jam, dried, processed products)
Flacourtia indica (Burm.f.) Merr.; Salicaceae; governor's plum	fr++ (jelly, jam, dried, processed products)
Fockea angustifolia K.Schum. (and other spp.); Apocynaceae; *kambro*	ro+++ (jam)
Garcinia livingstonei T.Anderson; Clusiaceae; African mangosteen	fr+++ (jam, juice, wine, dried, processed products)
Gethyllis species; Amaryllidaceae; *kukumakranka*	fr+++ (jam, niche products, novel flavours; sweets); M: fr+++ (digestives, tonics)
Grewia flava DC. (and other spp.); Tiliaceae; velvet raisin bush	fr++ (jam, juice, wine, dried, processed products)
Harpephyllum caffrum Bernh.; Anacardiaceae; wild plum	fr++ (jam, jelly, dried, processed products)
Heteropyxis natalensis Harv.; Myrtaceae; lavender tree	le++ (tea flavourant; sweets)
Hexalobus monopetalus (A.Rich.) Engl. & Diels; Annonaceae; shakama plum	fr+++ (jam, jelly, dried, processed products)

(continued on next page)

Table 1 (*continued*)

Species; family; common name(s) (partially or fully commercialized species are indicated in bold)	**Food use(s):** (ro)ot (incl. rhizome, tuber or bulb); (st)em; (le)af; (fl)ower; (fr)uit; (se)ed; (ex)udate; (es)sential oil; (oil); (ed)ible oil/seed oil/fixed oil
Hoodia gordonii (Masson) Sweet ex Decne. (and other spp.); Apocynaceae; *ghaap*, *ghôba*, hoodia	st++ (vegetable, appetite suppressant)
Hydnora africana Thunb.; Hydnoraceae; *kanni*, *jakkalskos*	fr++ (cold desserts, puddings)
Hyphaene coriacea Gaertn.; Arecaceae; ilala palm	ex (stem sap)+++ (wine); fr++ (processed products)
Lagenaria siceraria (Molina) Standl.; Cucurbitaceae; calabash, bottle gourd	young fr++ (vegetable)
Lannea edulis (Sond.) Engl. (and other spp); Anacardiaceae; wild grape	fr++ (jam, jelly, dried, processed products)
Leysera gnaphaloides (L.) L.; Asteraceae; *hongertee*, *duinetee*	le+++ (tea, health drinks, appetite stimulant)
Lippia javanica (Burm.f.) Spreng. (and other spp.); Verbenaceae; fever tea	le+++ (tea, health drinks)
Manilkara mochisia (Baker) Dubard (and other spp.); Sapotaceae; lowveld milkberry	fr+++ (jam, jelly, wine?, dried, processed products)
Mentha longifolia (L.) Huds.; Lamiaceae; wild mint, *ballerja*	le+++ (tea, health drinks, flavourant; sweets)
Mimusops zeyheri Sond. (and other spp.); Sapotaceae; red milkwood, *moepel*	fr+++ (jam, jelly, dried, processed products)
Momordica balsamina L.; Cucurbitaceae; balsam pear, African cucumber, *mohodu*	le+++, fr+++ (vegetable)
Monanthotaxis caffra (Sond.) Verdc.; Annonaceae; dwaba berry	fr++ (jam, jelly, dried, processed products)
Mondia whitei (Hook.f.) Skeels; Apocynaceae; *umondi*	ro+++ (spice, fragrance; sweets)
Moraea fugax (D.Delaroche) Jacq.; Iridaceae; *wituintjie*	ro+++ (health food)
Muraltia spinosa (L.) F.Forest. & J.C. Manning [= *Nylandtia spinosa* (L.) Dumort].; Polygalaceae; *cargoe*, *skilpadbessie*	fr+++(jam, jelly, dried, processed products)
Myrothamnus flabellifolius Welw.; Myrothamnaceae; resurrection plant, *bergboegoe*	le+++ (heath tea, flavourant, spice; sweets)
Nymphaea nouchali Burm.f.; Nymphaeaceae; water lily	st++ (vegetable, processed products?)
Olea europaea L. subsp. ***africana*** (Mill.) P.S.Green; Oleaceae; wild olive	fr++ (jam?, processed products?)
Orthanthera jasminiflora (Decne.) Schinz.; Apocynaceae	fr+++ (vegetable)
Osteospermum moniliferum L. [= *Chrysanthemoides monilifera* (L.) Norl.]; Asteraceae; *bietou*	fr+++ (jam, dried, processed products; sweets; flavourant?)
Oxalis pes-caprae L.; Oxalidaceae; sorrel, *suring*	le+++ (culinary herb)
Oxygonum alatum Burch.; Polygonaceae	le++ (culinary herb, vegetable)
Pappea capensis Eckl. & Zeyh.; Sapindaceae; jacket-plum	fr+++(jam, jelly, dried, processed products); se++ (edible oil)
Parinari capensis Harv., and *P. curatellifolia* Planch. ex Benth.; Chrysobalanaceae; mobola plum	fr++(fresh or dried fruit, jelly, wine, processed products); se++ (edible nuts, oil)
Pelargonium graveolens L'Hér. (and other spp.); Geraniaceae; rose geranium	es+++ (flavourant)
Pennisetum glaucum (L.) R.Br.; Poaceae; pearl millet, *babala*	fr+++ (snack foods, health foods, breakfast cereals, popcorn; traditional beers)
Pentarrhinum insipidum E.Mey.; Apocynaceae; *leswa*	le and young fr+++ (vegetable)
Pergularia daemia (Forssk.) Chiov.; Apocynaceae; *eriko*	le+++ (vegetable)
Phoenix reclinata Jacq.; Arecaceae; wild date palm	fr++ (processed products); young st++ (palm hearts/vegetable); stem sap+++ (palm wine)
Plectranthus esculentus N.E.Br.; Lamiaceae; wild potato	ro+++ (vegetable)
Quaqua incarnata (L.f.) Bruyns and *Q. mammillaris* (L.) Bruyns; Apocynaceae; *aroena*	st++ (vegetable, salad ingredient?)
Rafnia acuminata (E.Mey.) G.J.Campbell & B.-E.van Wyk, *R. amplexicaulis* (L.) Thunb.; Fabaceae; *soethoutbossie*, *veldtee*	le++ (tea); ro+++ (flavourant, sweetener; sweets)
Rhoicissus tomentosa (Lam.) Wild.& R.B.Drumm. (and other spp.); Vitaceae; wild grape	fr+++(jam, jelly, vinegar, dried?, processed products?)
Rubus rigidus Sm. (and other spp.); Rosaceae; wild bramble	fr+++ (edible fruit, jam, jelly, cold drinks)
Rumex lanceolatus Thunb. (and other spp.); Polygonaceae; wild sorrel	le++ (vegetable, culinary herb)
Salacia kraussii (Harv.) Harv.; Celastraceae; *ibontsi*	fr++(jam, jelly, processed products)
Salicornia species; Chenopodiaceae; *seekoraal*	le++ (salad ingredient)
Schotia brachypetala Sond. (and other spp.); Fabaceae; weeping boerbean	se++ (roasted, as nut)
Sclerocarya birrea (A.Rich.) Hochst.; Anacardiaceae; marula	fr+++ (edible fruit, wine/beer, flavourant, processed products, sweets); se+++ (nuts, edible oil)
Sclerochiton ilicifolius A.Meeuse; Acanthaceae	ro++ (natural sweetener—monatin)
Searsia lancea (L.f.) F.A.Barkley; Anacardiaceae; *karee*	fr++ (edible fruit, processed products, traditional sweets)
Searsia undulata (Jacq.) T.S.Yi et al.; Anacardiaceae; *njara(bessie)*	fr++ (edible fruit, processed products, traditional sweets)
Sesamum triphyllum Welw. ex Asch.; Pedaliaceae; wild sesame	se++ (edible seed, used like sesame; snack foods)
Siphonochilus aethiopicus (Schweinf.) B.L.Burtt; Zingiberaceae	ro+++(spice, flavourant, sweets)
Solanum retroflexum Dunal; *S. chenopodioides* Lam., *S. nigrum* L., Solanaceae; *umsoba*, *msoba*	fr++(jam, jelly, processed products)
Solenostemon rotundifolius (Poir.) J.K.Morton; Lamiaceae; Zulu round potato, *amadada*	ro++ (vegetable)
Sorghum bicolor (L.) Moench; Poaceae; sorghum, *mabele*, *amabele*	fr+++ (snack foods, health foods, breakfast cereals, popcorn?; traditional beers); ste++ (sweetener—*S. docha* type)
Strychnos cocculoides Baker; Stilbaceae; corky monkey apple	fr+++(jam, jelly, processed products)
Strychnos spinosa Lam.; Stilbaceae; green monkey apple	fr+++(jam, jelly, processed products)
Sutherlandia frutescens (L.) R.Br.; Fabaceae; cancer bush	le+++ (health drinks)
Syzygium cordatum Hochst. ex C.Krauss (and other spp.); Myrtaceae; water berry, *umdoni*	fr++(jam, jelly, processed products)

Table 1 (*continued*)

Species; family; common name(s) (partially or fully commercialized species are indicated in bold)	**Food use(s):** (ro)ot (incl. rhizome, tuber or bulb); (st)em; (le)af; (fl)ower; (fr)uit; (se)ed; (ex)udate; (es)sential oil; (oil); (ed)ible oil/seed oil/fixed oil
Talinum caffrum (Thunb.) Eckl. & Zeyh. (and other spp.); Portulacaceae; *kgalahete*, *osbossie*,	le+++ (vegetable; salads)
Tetragonia decumbens Mill.; Aizoaceae; dune spinach	le++ (vegetable)
Trachyandra divaricata (Jacq.) Kunth; Asphodelaceae; dune cabbage	young fl+++ (vegetable)
Trachyandra falcata (L.f.) Kunth (and other spp.); Asphodelaceae; wild cabbage	young fl+++ (vegetable)
Trichilia dregeana Sond., ***T. emetica*** Vahl; Meliaceae; *umkhuhlu*, Natal mahogany	se(aril)++ (vegetable)
Tulbaghia alliacea L.f.; Alliaceae; wild garlic	le++ (culinary herb)
Tulbaghia capensis L.; Alliaceae; Cape wild garlic	le+++ (culinary herb)
Tulbaghia violacea Harv.; Alliaceae; wild garlic	le+ (culinary herb)
Tylosema esculentum (Burch.) A. Schreib.; Fabaceae; marama bean	se+++(pulse)
Tylosema fassoglense (Schweinf.) Torre & Hillc.; Fabaceae; climbing marama bean	se++(pulse)
Uvaria lucida Benth.; Annonaceae; large cluster-pear	fr++ (fresh or dried fruit, jam, juice, sweets)
Vangueria infausta Burch.; Rubiaceae; wild medlar	fr+++ (fresh or dried fruit, jam, processed products)
Vigna subterranea (L.) Verdc.; Fabaceae; jugo bean, African groundnut	se+++ (vegetable, nut, snack foods, health foods)
Vigna unguiculata (L.) Walp.; Fabaceae; cowpea	se+++ (pulse, snack foods); le+++ (vegetable, fresh or dried, processed products)
Vigna vexillata (L.) A.Rich.; Fabaceae; wild sweetpea	se++ (pulse, snack foods); le++ (vegetable, fresh or dried, processed products)
Viscum capense L.f.; Viscaceae; Cape mistletoe, *litjiestee*	M: st+++ (health tea, tonic drinks)
Warburgia salutaris (Bertol.f.) Chiov.; Canellaceae; pepperbark tree	le+++ (spice)
Withania somnifera (L.) Dunal; Solanaceae; Indian ginseng, *geneesblaarbossie*	ro+++ (tonic drinks)
Ximenia americana L., ***X. caffra*** Sond.; Olacaceae; sourplum	fr+++ (fresh or dried fruit, jam, juice, sweets); se+++(nuts, edible oil)
Ziziphus mucronata Willd.; Rhamnaceae; buffalo-thorn, *mokgalo*	fr++ (jam, juice, wine, processed products)

unguiculata) is internationally well established as an important crop of African origin (Figs. 2 and 4C,D). Other, lesser known examples of edible seeds include *Bauhinia petersiana* (Fabaceae), *Brabejum stellatifolium* (Proteaceae—extensive leaching is required to remove cyanogenic glycosides), *Guibourtia coleosperma* (Fabaceae), *Leucadendron pubescens* (Proteaceae), *Schotia afra*, *S. brachypetala* and *S. latifolia* (Fabaceae), *Sesamum capense* and *S. triphyllum* (Pedaliaceae), *Strelitzia nicolai* (Strelitziaceae) and *Ximenia caffra* and *X. americana* (Olacaceae).

3.2. Fruits

A list of indigenous fruits with commercial potential is given in Table 1 and several examples are shown in Fig. 1. Indigenous fruits are not only an important source of vitamins and other nutrients for children in rural areas, but are sometimes central to the survival of local communities, such as *tsama* (*Citrillus lanatus*) in the Kalahari, *nara* (*Acanthosicyous horridus*) in Namibia and the *mongongo* (*Schinziophyton rautanenii*) in northern Botswana (Van Wyk and Gericke, 2000; see also the popular review by Swart, 1988–1991). Others are important items of trade and are sold along roadsides in many parts of southern Africa. Indigenous examples include snot apple (*Azanza garckeana*), corky monkey apple (*Strychnos cucculoides*), green or spiny monkey apple (*S. spinosa*), *suurvye* (*Carpobrotus edulis*), *umsoba* (*Solanum retroflexum*) in the eastern parts of South Africa, Kei-apple (*Dovyalis caffra*), *stamvrug* (*Englerophytum magalismontanum*), sourplum (*Ximenia caffra*), blue sourplum (*X. americana*) and *moepel* or red milkwood (*Mimusops* species). Several fruits have potential as new commercial crops and progress has already been made with marula (*Sclerocarya birrea*) and a few others. In the case of marula, yields of three tons per tree have been recorded (Holzhausen, 1993) and the weight of individual fruits can be as much as 98 g. Marula is famous as the source of the flavour of Amarula liqueur (Figs. 1 and 4C) and is also used to produce delicious sweets (Figs. 1 and 4B, similar to fruit rolls). Species that have been tested in trial plantings include marula, wild medlar (*Vangueria infausta*), wild plum (*Harpephyllum caffrum*), jackal-berry (*Diospyros mespiliformis*), velvet raisin bush (*Grewia flava*) and Kei-apple (*Dovyalis caffra*). Ackhurst (1996) evaluated all southern African fruits in terms of their abundance, nutritional value, palatability, size and yield and proposed that the following fruits have exceptional potential: marula, sourplum, blue sourplum, jacket plum (*Pappea capensis*), baobab (*Adansonia digitata*), mobola plum (*Parinari curatellifolia*), African mangosteen (*Garcinia livingstonei*), forest milkberry (*Manilkara discolor*), the common cluster fig (*Ficus sycamorus*), green monkey apple and black monkey apple (*Strychnos madagascariensis*), wild custard apple (*Annona senegalensis*) and wild date palm (*Phoenix reclinata*). Ham et al. (2008) discussed the commercial potential and opportunities for developing new enterprises based on indigenous fruits.

Analyses of the nutritional value and vitamin C content of wild fruits are available (Wehmeyer, 1966, 1976; see also the tables in Fox and Norwood Young, 1982; Arnold et al., 1985). To these may be added various members of the Cucurbitaceae (see Table 1), of which *Cucumis metuliferus* (jelly melon) is perhaps the best-known example. This African plant is commercially cultivated in Kenya and New Zealand (Bates and Robinson, 1995) and has become known as "Kiwano", a registered trade mark (Morton, 1987). *Citrillus lanatus*, *Lagenaria siceraria*, *Cucumis* species and several others are very important food sources in southern Africa (MacCrone, 1937; Story, 1959; Renew, 1968; Malan and Owen-Smith, 1974; Bohme, 1976; Dentlinger, 1977; Maguire, 1978; Steyn, 1981; Kirkbride, 1993; Bates et al., 1990, 1995; Bates and Robinson, 1995) and have considerable potential

Fig. 1. Examples of South African indigenous fruits with commercial potential for developing new crops and new products (edible fruits, dried and processed fruits, fruit juices, heath products, jams, chutneys, sweets, fruit flavours and liqueurs). 1A–C, *Adansonia digitata*—baobab (1A, leaves and flower; 1B, fruits and seeds; 1C, aloe gel drink containing baobab); 1D, *Berchemia discolor*—brown ivory; 1E, *Carissa macrocarpa—amatungulu*; 2A–B, *Carpobrotus edulis*—sour fig (2A, ripe fruit; 2B, dried fruit); 2C, *Citrillus lanatus*—tsama melon; 2D, *Cucumis metaliferus*;—jelly melon; 2E, *Cucumis zeyheri*—wild cucumber; 3A, *Diospyros mespiliformis*—jackal-berry; 3B–C, *Dovyalis caffra*—Kei-apple (3A, fruits; 3B, liqueur); 3D, *Manilkara mochisia*—lowveld milkberry; 3E, *Mimusops zeyheri*—red milkwood; 4A–C, *Sclerocarya birrea*—marula (4A, ripe fruits; 4B, marula sweets; 4C, marula liqueur); 4D, *Solanum retroflexum—msoba* (fruits and jam); 4E, *Vangueria infausta*—wild medlar. Photographs: all by B.-E. van Wyk.

for new product development. A wide diversity of products can be derived from fruits; they can be eaten fresh or dried, processed into sweets, fruit juices, jams, jellies, chutneys, vinegars, wines, liqueurs and novel flavours. The seeds are often edible as nuts or contain valuable oil for culinary or cosmetic uses, as noted long ago by Schweikerdt (1937) and reviewed by Viljoen, 2011b-this issue. Innovative processing may allow the use of fruits that are currently considered too small to be of any commercial interest, despite their delicious taste (such as *Grewia flava* and *Osteospermum moniliferum*). The value of indigenous fruits in traditional fermented drinks ("beers") is discussed later on.

3.3. Vegetables and culinary herbs

Green leaves of various indigenous species are eaten fresh or they may be cooked and eaten with porridge as a relish (called spinach, *morogo* or *imfino*). Leaves may also be briefly cooked and then sun-dried and stored for later use or for trading on local markets, especially species of *Amaranthus*, *Cleome*, *Corchorus and Vigna.* These products are ideal for processing as canned foods; canned *Amaranthus*, for example, is becoming more regularly available nowadays. The most popular indigenous species are listed in Table 1 and some examples are shown in Fig. 2.

Cleome gynandra and *C. monophylla* are grown on a small scale as crop plants, yielding two tons or more per hectare (Van den Heever and Coertze, 1997). *Corchorus* species, including *C. tridens* (Fig. 2 and D), *C. asplenifolius* Burch. and exotic weedy species (*C. olitorius* L. and *C. trilocularis* L.) are popular traditional vegetables with commercial potential, as are the leaves and young fruits of *Pentarrhinum insipidum* (Figs. 2 and 3A). These vegetables are exceptionally nutritious (Fox and Norwood Young, 1982; Arnold et al., 1985; see also Shanley and Lewis, 1969; Rose, 1972; Rose and Jacot Guillarmod, 1974; Santos Oliveira and Fidalgo de Carvalho, 1975; Ogle and Gravetti, 1985). Other noteworthy vegetables of commercial interest are *waterblommetjies* (*Aponogeton distachyos*) which is available as a canned product (Fig. 2 and A,B) and nowadays served at restaurants offering traditional Cape quisine. Recipes for the traditional stew can be found in Coetzee (1977), Leipoldt (1976) and Rood (1994, 2008). Another typical Cape stew is made from the young inflorescences of *Trachyandra* species (Figs. 2 and 3D,E), including *T. falcata* (wild cabbage, *veldkool*), *T. divaricata* (*strandkool*), *T. ciliata* (L.f.) Kunth (*veldkool*) and *T. hispida* (L.) Kunth. (hairy *veldkool*). Recipes are given by Leipoldt (1976, 1978) and Rood (1994, 2008). *Allium dregeanum* (*wildeprei* or wild leek) (Figs. 2 and 1A) and *Tulbaghia* species (wild garlic) (Figs. 2 and 4E,F) are sometimes used as culinary herbs. It may

Fig. 2. Examples of South African indigenous vegetables and pulses with commercial potential for developing new crops and new products (leafy vegetables, root vegetables, culinary herb and snack foods). 1A, *Allium dregeanum*—wild leek; 1B–C, *Aloe ferox*—Cape aloe (1B, yoghurt containing aloe gel; 1C, aloe jam); 1D, *Amaranthus* species—*marogo*; 1E, *Annesorhiza nuda*—anise root; 2A–B, *Aponogeton distachyos*—*waterblommetjie* (2A, leaves and flowers; 2B, canned product); 2C, *Chamarea* species—*vinkelwortel*; 2D, *Corchorus tridens*—*ligusha*; 2F, *Fockea* species—*kambro* (traditional jam); 3A, *Pentarrhinum insipidum*—*leshwa*; 3B, *Plectranthus esculentus*—wild potato, Livingstone potato; 3C, *Solenostemon rotundifolius*—Zulu round potato; 3D, *Trachyandra falcata*—wild cabbage, *veldkool*; 3E, *Trachyandra divaricata*—dune cabbage, *duinekool*; 4A–B, *Vigna subterranea*—jugo bean (4A, plant with pods; 4B, seeds); 4C–D, *Vigna unguiculata*—cowpea (4A, plant with pods; 4B, seeds); 4E–F, *Tulbaghia capensis*—Cape wild garlic (4E, leaves and flowers; 4F, dormant bulb). Photographs: all by B.-E. van Wyk.

be feasible to develop these plants as new vegetables for use in speciality restaurants. A large number of indigenous species are available for use as novel fresh salad ingredients. Young and fleshy parts possibly suitable for this use are *Aponogeton distachyos* (flowers) (Fig. 2 and A), *Chamarea* species (roots) (Fig. 2 and C); *Gasteria* (flowers), *Hoodia* (stems, perhaps thinly sliced or grated), *Microloma* (young fruits), *Oxalis pes-caprae* and other species (leaves and fleshy roots), *Oxygonum alatum* (seedlings), *Pectinaria maughamii* (stems), *Pelargonium fulgidum* (leaves), *P. gibbosum* (leaves), *Pentarrhinum insipidum* (leaves and young fruits), *Portulacaria afra* (leaves), *Quaqua* species (stems), *Salicornia* species (stems) and *Talinum* species (leaves).

Indigenous root vegetables are traditionally important in South Africa as a source of starch, such as the Livingstone potato (*Plectranthus esculentus*) (Figs. 2 and 3B) and the Zulu round potato (*Solenostemon rotundifolius*) (Figs. 2 and 3C). Indigenous starch sources have largely been replaced by the non-indigenous potato (*Solanum tuberosum*), sweet potato (*Ipomoea batatas*) and *indumbe* (*Colocasia esculenta*). In the Cape region, various bulbs and corms, collectively known as *uintjies*, were once important food items, as were *kambro* (*Fockea* species), *baroe* (*Cyphia* species) and *vinkelwortel* (*Chamarea* species) as water sources and snack foods (Archer, 1982; Rood, 2008). Most *uintjies* belong to one of four important "*uintjie* families", the Cyperaceae, Iridaceae, Tecophilaeaceae and Oxalidaceae (Van Wyk and Gericke, 2000). These food items were harvested only in the wet season and either eaten fresh or more typically baked in hot ash or cooked in milk.

The species are listed and briefly described in Van Wyk and Gericke (2000). An example is the *raapuintjie* (*Cyanella hyacinthoides*), once an important staple food in the Cape because of its relatively large size (14 g) and high protein content (Archer, 1982). Another important uintjie is *Moraea fugax* (*wituintjie*), first reported by Van der Stel (1685). *Anyswortel* (*Annesorhiza macrocarpa* and *A. nuda*) were once collected and sold on a small scale in the Cape as root vegetables (Forbes, 1986; Smith, 1966). Some of these indigenous vegetables deserve more attention as potential crop plants and as sources of novelty food items for speciality restaurants catering for the tourist trade. Research on the cultivation of *Plectranthus esculentus* (Figs. 2 and 3B) and *Solenostemon rotundifolius* (Figs. 2 and 3C) at the Agricultural Research Council's Vegetable and Ornamental Plant Institute at Roodeplaat has shown both to be viable crops (Alleman and Coertze, 1996). *Solenostemon* is potentially valuable, yielding between five and 15 tons of highly nutritious tubers per hectare (Alleman, pers. comm.). The fleshy tuber of *kambro* (various *Fockea* species) is used on a small scale to produce *kambro* jam, a local delicacy (Fig. 2 and E) or it can be eaten as a sweet side dish like sweet potato (Rood, 2008).

3.4. Flavours, spices and sweeteners

In the editorial preface to a special issue of The Journal of Essential Oil Research that was devoted to South Africa, Lawrence (2006) called the country a global epicentre of aromatic plants, with large numbers of species in the Asteraceae, Rutaceae, Lamiaceae and Geraniaceae producing essential oil that are potentially valuable as new commercial flavours and fragrances. A few well-known species are listed in Table 1, but details on numerous other essential oil-producing species can be found in this important publication. One of the most popular commercialised flavours from the Cape is that of *Agathosma betulina* (reviewed by Moolla and Viljoen, 2008).

Aromatic plants that are of interest as sources of new flavours for the food industry include *Heteropyxis natalensis*, *Mentha longifolia*, *Myrothamnus flabellifolius*, *Pelargonium graveolens*, *Siphonochilus aethiopicus* and *Warburgia salutaris* (Table 1). New fruity flavours may also be derived from esters and other volatile compounds in the fruits of *Gethyllis* species, *Osteospermum moniliferum*, *Parinari curatellifolia*, *Sclerocarya birrea*, and numerous others listed in Table 1 that have yet to be explored.

Spices are relatively rare in southern Africa but *Mondia whitei*, *Myrothamnus flabellifolius*, *Siphonochilus aethiopicus* and *Warburgia salutaris* deserve more attention. The fleshy roots of *Mondia whitei* have a delicious vanilla-like flavour (Crouch et al., 1998; Aremu et al., 2011-this issue) and its commercial potential as a spice has been alluded to several times in the literature. *Myrothamnus flabellifolius* is a traditional spice in southern Africa and is used to add flavour to tea. It has remarkable anti-microbial activity (Van Vuuren and Viljoen, 2006) and may therefore also be of interest in the development of health drinks, throat lozenges, mouth rinses and dental care products. The rhizomes and roots of *Siphonochilus aethiopicus* have a delicious spicy taste and are used to flavour biscuits and other confectionery. It has considerable potential in the development of new functional foods. The leaves of *Warburgia salutaris* are very pungent and peppery (hence the common name pepperbark tree) and are used in the KwaNibela area of KwaZulu-Natal as a spice to improve the taste of food (Corrigan et al., 2011).

Indigenous plants are also a potential source of novel sweeteners. The roots of *Sclerochiton ilicifolius* contain monatin, an amino acid that tastes 1200 times sweeter than a 10% sucrose solution. Synthesised monatin has potential for large-scale commercial use in cold drinks (Holzapfel and Olivier, 1993). The yellow roots of *Rafnia amplexicaulis* are sweet-tasting and were once used in the Cape as a licorice substitute (Pappe, 1847, 1868). Another traditional source of sweetener is a sweet-stemmed form of *Sorghum bicolor*, previously known as *S. dochna*, which is chewed like sugar cane in rural areas.

3.5. Teas and herbal beverages

The best-known herbal tea of South Africa is rooibos tea (*Aspalathus linearis*) but its numerous wild forms (such as the grey, brown, black, Nieuwoudtville and Wupperthal types) have their own subtle flavours and some success has already been achieved to develop these for niche markets. Rooibos tea has been used as an ingredient in cosmetics, slimming products, as a colouring and as a flavouring agent in baking, cooking and cocktails (Rooi Tea Control Board, 1973). The main phenolic compound is aspalathin, a dihydrochalcone (Joubert, 1996; Joubert and De Beer, 2011-this issue). Tea made from a closely related, poorly known species, *A. pendula*, has a rich golden colour and a delicious taste. It was traditionally added to commercial rooibos with the belief that it enhances the fermentation process.

The rooibos tea industry represents a special success story in indigenous product development and marketing (Van der Walt and Machado, 1992). Exports to Germany alone exceed the local consumption since 2004 (Martin Bergh, personal communication) and the annual production has recently reached 180,000 tons (Department of Agriculture, Forestry and Fisheries, 2010).

The various species of *Cyclopia* (honeybush tea) are relatively well known and were recently turned into commercial crops (Van Tonder, 1981; Smit, 1982; De Lange, 1997; Joubert et al., 2011-this issue), especially *C. genistoides* (the original Cape honeybush), *C. intermedia* (*bergtee* or mountain tea), *C. subternata* (*vleitee* or *vlei* tea) and *C. sessiliflora* (Heidelberg tea). It is interesting to note that the main phenolic compound in honeybush tea is mangiferin (De Nysschen et al., 1996; Joubert et al., this issue), a xanthone of considerable medicinal interest that is currently under commercial development as a new medicine in Cuba (the product is known as Vimang). Several other indigenous species are widely used in the same way as black tea (but often with implied or explicit claims of health benefits). In the northern parts of South Africa, bushman's tea or Zulu tea (*Athrixia phylicoides*) and daisy tea (*A. elata*) are quite popular (Smith, 1966; Joubert et al., 2008). *Hongertee* or *duinetee* (*Leysera gnaphaloides*, Asteraceae) is an excellent general health tea with an aromatic fragrance (Van Wyk and Gericke, 2000). This traditional infusion of the west coast of South Africa is said to stimulate appetite and seems suitable for development as a new commercial health tea. In various parts of South Africa, *Mentha longifolia* (known as *ballerja*) is used as a refreshing herbal tea or is added to black tea. Twigs and leaves of the resurrection plant or *berg-boegoe* (*Myrothamnus flabellifolius*) (Myrothamnaceae) are used as a medicinal tea and may be added to normal (black) tea (Rood, 2008). A refreshing tea may also be brewed from the leaves of *Combretum apiculatum* (red bushwillow) (Van Wyk and Gericke, 2000).

In recent years an increasing number of herbal tonic drinks became available in South Africa, based mainly on aloe gel derived from *Aloe ferox*. The "jelly" used for these drinks are produced using a patented method to release the polysaccharides from the leaf material (O'Brien et al., 2011-this issue). Other species of *Aloe* (and related genera such as *Bulbine*) may be useful and practical alternative sources of gel but these need further investigation. The popularity of health foods and functional foods suggests that there may be opportunities for developing new herbal drinks with carefully selected plant extracts and other ingredients chosen for their health benefits, in additional to what they may contribute in terms of flavour and taste. Species listed under new flavours and spices deserve special attention in this context.

3.6. Alcoholic beverages

Arguably the most interesting potential source of new products is the rich diversity of traditional alcoholic beverages, loosely referred to as wine, beer and brandy.

Sorghum beer (made from *Sorghum bicolor* malt) is one of the most important commercial beverages in South Africa and is mass produced using standardised methods. Traditional malted beers are nutritious and form an essential component of the diet in rural areas. There is a rich diversity of beer types, based mainly on sorghum, pearl millet and finger millet but also on non-traditional maize. Quin (1959) for example, gave details of the main traditional beers (*bjalwa*) of the North Sotho (Pedi), including the malting and brewing methods (see also Coetzee, 1982). It is hoped that the increasing awareness of the value of diversity and its potential in tourism will lead to a revival of the traditional art of brewing (using old recipes with special methods and ingredients), so that more people in future will be able to appreciate the regional diversity of tastes (Van Wyk and Gericke, 2000). Malted beers have already been discussed under cereals above, so that the focus is here on wines ("fruit beers") and distilled alcoholic beverages.

Of particular value to rural communities is palm wine, which is prepared in the Maputaland region of South Africa from the phloem sap of *Hyphaene coriacea* (ilala palm) and to a lesser extent from *Phoenix reclinata* (wild date palm) (Moll, 1972; Cunningham, 1990a, 1990b). Large trees can yield more than 60 l of sap (Meredith, 1948). Palm wine will hopefully become more freely available in South Africa. It is a low-alcohol (3.6%), delicious, refreshing and nutritious drink, adding substantial quantities of nicotinic acid, vitamin C and potassium to the diet (Nash and Bornman, 1973; Cunningham and Wehmeyer, 1988).

Drinks made from the sugary juice of fruits, honey or the sap tapped from palm trees are usually referred to in South Africa as "beer" but are perhaps more correctly called wine. The most popular traditional drink in the Cape region was mead ("honey beer"), known by the Khoi-San name *karri* or *karee*. The traditional method of making it was described in Van Wyk and Gericke (2000). The fruits of various species of *Searsia* are considered essential ingredients, as are a diversity of roots that are traditionally used as ferments (listed by Van Wyk and Gericke, 2000). *Karri* is a delicious drink and has already been commercialised in the Eastern Cape Province of South Africa, under the Xhosa name *iQhilika*. It is hoped that it will soon rival *tej* (the famous Ethiopian traditional mead) in both availability and popularity.

A diversity of indigenous fruits are used to produce wine ("beer"), of which marula (*Sclerocarya birrea*) is the best known. Marula wine has been sporadically available in South Africa and it is hoped that entrepreneurs will grasp the opportunity to fully commercialise and brand this delicious and uniquely African drink, also known as *mokhope* (Krige, 1937) or *ubuganu* (Cunningham, 1990b). The methods of making marula wine are described by Quin (1959) and Junod (1913, 1962). Examples of other fruits traditionally used for wine-making ("beer-brewing") include *Berchemia discolor* (brown-ivory), *Diospyros mespiliformis* (jackal-berry), *Englerophytum magalismontanum* (*stamvrug*), *Garcinia livingstonei* (African mangosteen), *Grewia flava* (velvet raisin bush), *Parinari curatellifolia* (mobola plum), *P. capensis* (dwarf mobola plum) and *Ziziphus mucronata* (buffalo thorn). The flavours of indigenous fruit are ideally suited for making tasty liqueurs, such as the world famous Amarula®, which is flavoured with amarula fruits (*Sclerocarya birrea*). Innovative new jams, jellies and liqueurs based on indigenous fruits have recently been developed

by researchers at the Agricultural Research Council (ARC) Infruitec-Nietvoorbij and also at the ARC Institute for Tropical and Subtropical Crops (ARC-ITSC) at Nelspruit.

Strong alcoholic drinks such as *buchu* brandy, *mampoer*, *shiwayawaya* and *shikokiyane* or *skokiaan* (Junod, 1913, 1962) are an interesting part of the cultural heritage of South Africa and deserve more attention as tourist attractions. These potent drinks are traditionally distilled from fermented fruits (*mampoer*), fermented juice of sugar cane (*shiwayawaya*) and from golden syrup or palm wine laced with sugar (*skokiaan*). Brandy flavoured with buchu (*Agathosma betulina*) is an old Cape favourite and makes an excellent cocktail when mixed with lemonade and/or tonic water according to taste.

4. Discussion

Indigenous foods and flavours that form the basis of substantial industries have long histories of product development and innovative marketing. Much can be learnt from the marketing successes achieved by breakfast cereals and traditional beers based on malted mabele (sorghum), rooibos tea (Van der Walt and Machado, 1992) and the world famous cream liqueur (Amarula®). There is no doubt that similar opportunities exist for market-driven development projects based on the indigenous plant species listed in Table 1. Novelty has become an important selling point in modern markets—people are always looking for something new. A wide range of interesting new products can be visualised, including new foods and beverages that reflect the cultural diversity of South Africa. It is also important to ensure that local communities benefit from the use of their traditional resources.

Basic research is needed to explore the botanical, horticultural, chemical and nutritional properties of indigenous food plants. Botanical studies are needed to select the best genotypes for cultivation, while horticultural studies may contribute to the development of cultivation techniques for "difficult" species such as *Myrothamnus flabellifolius.* Fruits trees pose a considerable challenge because of the long period that is required for new crop development. Wild-harvesting may not be sustainable and the best long term option is cultivation, which will not only ensure a predictable supply of raw materials, but also reduce the natural variability found in wild plants, thus ensuring a more consistent product quality. Unexpected problems relating to post-harvest treatments and other technological challenges may arise, so that food technologists and food engineers have a crucial role to play in the development of viable, commercial products. The almost complete absence of nutritional data for African food plants in the widely used international reference source on food composition (Souci et al., 2000) is noteworthy. Available information is scattered in the literature and a new focus on nutritional analyses is necessary to follow on the pioneering work of Wehmeyer (1966, 1976); see also Fox and Norwood Young (1982) where Wehmeyer's work was included—the table of nutritional analyses of common foods on page 64, and analyses of leaf vegetables by Wehmeyer and Rose on page 376. More research in food science is an obvious priority, as are a concerted effort to understand and exploit local and international markets.

There has been an increased awareness of the importance of indigenous food products, so that numerous new small-scale product development activities are currently underway in various parts of South Africa. This should be evident from visiting any traditional market or farm stall and observing the innovative new ways in which traditional products are offered for sale. The new enthusiasm may at least partly be inspired by the recent successes achieved in the rooibos tea, honeybush tea and aloe industries, and by the spectacular marketing success of Amarula as an African liqueur.

5. Conclusions

This review has highlighted the large number and wide range of food plant species with commercial potential, many of which have not yet received any attention from research institutions, development agencies and commercial enterprises. It is likely that several new foods and beverages, including functional foods, health drinks, beers, fruit wines, cocktails, herbal teas, spices and flavours will be developed in the near future. The combination of an exceptionally rich plant diversity and an equally rich cultural diversity in South Africa presents unique opportunities to develop traditional dishes and beverages into new food products for local and international markets and to enhance the unique cultural and gastronomic experiences of tourists visiting the country. A substantial part of the income of the aloe industry in the southern Cape, for example, is already based on tourism. This reviewer looks forward to the day when uniquely South African beverages such as *karee* (traditional mead), marula beer, palm wine and buchu brandy become freely available alongside wine and beer, and when a diversity of new dishes based on indigenous vegetables and fruits are offered to tourists in local restaurants. It is also hoped that smaller industries based on indigenous products will become more and more competitive in local and international markets.

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