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JESSENIA BATAUA: A UNIQUE OIL-PALM WITH POTENTIAL FOR COMMERCIAL CULTIVATION IN THE CARIBBEAN

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ABSTRACT

Jessenia bataua (Mart.) Burrett is an oil palm with great commercial potential. Its preponderance of unsaturated oils, produced in abundance and virtually identical to olive oil, makes it desirable for cooking purposes and for health reasons. Its natural, but by no means exclusive, market would be those parts of Europe and North America where olive oil is valued and used. As a plantation crop, jessenia is well suited to those areas of the Caribbean with well drained, fertile soils and reliable tropical rainfall patterns. Selected areas of the Caribbean would be good choices for cultivation of *J. bataua* for several reasons. First, the Caribbean has well established trading ties with North America, Britain, and France and, potentially, the rest of the European Economic Community. Second, as a specialty crop of perhaps limited production potential by the standards of larger, more developed nations, it is admirably suited to relatively small, intensively cultivated areas and to governments small enough and concerned enough that they could take sufficient interest in its successful cultivation and promotion to ensure its commercial success.

Next to grasses, [the palms] are the most generally useful of all plants.... Among the products yielded by palms are sugar, "milk," fat, wax, textile fabrics, wood for building, and leaves for making thatch, baskets, mats, and the like. **E.W. Eckey, p.302**

Many species of palm are potentially valuable for commercial oil extraction. **M.J. Balick, p.11; emphasis added.**

INTRODUCTION

Commercially, botanically, and among local populations the Palm Family is held in high esteem. Its products, especially oils and fats, are greatly valued by both indigenous peoples and the multinational food processors. The major source of commercial palm oil, ***Elaeis guineensis***, is cultivated on plantations in Africa, Asia, and South America. There is, however, one great drawback to human consumption of palm oil--like coconut oil, it is a prototypic saturated vegetable fat; its major component, palmitic acid, has no double carbon bonds. Consequently, many scientists link its use to increased serum cholesterol levels in human blood and increased risk of heart disease (Trevisan et al., 1990). Oils that are monounsaturated (olive) and polyunsaturated (corn, safflower, soybean, and canola) are recommended over coconut and palm and palm kernel oils (known collectively as tropical oils) whose properties are similar to such animal fats and oils as beef fat, tallow, and lard.

Among eight palm genera that yield oil, two closely related Amazonian genera, ***Jessenia*** and ***Oenocarpus***, yield high quality monounsaturated oils with potential for adaptation to plantation cultivation. One species in particular, ***J. bataua***, shows particular promise. In great demand locally and in nearby South American cities, the oil from this palm has been favorably commented upon by Europeans since its "discovery" in the nineteenth century. Chemically, too, it has received high marks for its purity and monounsaturated quality.

Because it is virtually identical to olive oil, its natural markets are Europe and North America, to be marketed as a specialty or gourmet oil, not unlike Swiss walnut oil which is expensive and highly esteemed. In the case of jessenia oil, there would not be the disadvantage, as there is with some specialty oils, of a strong intrinsic flavor that some consumers might justifiably object to.

As a specialty oil, its extent of cultivation and its commercial potential most likely would be limited. Because of this, it is ideally suited to culture in the Caribbean, an area historically noted for such specialties as St. Vincent arrowroot, Jamaican ginger and allspice, and Grenada nutmeg and mace. The challenge is to determine an area in the

Caribbean that would best match the climatic and soil conditions of jessenia's area of natural distribution to best ensure its successful establishment in the Caribbean.

LITERATURE REVIEW

Fats and oils

T.P. Hilditch (1956) points out the paradox that "the fats of the simplest and most primitive organisms are usually made up of a very complex mixture of fatty acids [while], as biological development has proceeded, the chief component acids of the fats of higher organisms have become fewer in number. In the animal kingdom this change in type is remarkably progressive and culminates, in the depot fats of the higher land animals, in fats in which oleic, palmitic, and stearic acids are the major components. In vegetable seed fats, as a rule, similar simplicity is seen in the major component acids..Fruit coat fats ..include palmitic and oleic acids as sole major components, irrespective of the plant family in which they occur; linoleic acid is also frequently present, but usually only in minor quantities." Of these fatty acids, "oleic acid [a monounsaturated fatty acid] is undoubtedly the most widespread of all natural fatty acids. In very many fats it forms more than 30 percent of the total fatty acids and up to the present has been found absent in no natural fat or phosphatide.... Two others appear to be nearly as ubiquitous: [polyunsaturated] linoleic and (monounsaturated) palnitoleic."

Palmitic is a characteristic saturated fatty acid occurring prominently in many oils, to which it may contribute 15 to 50 percent. Only myristic and stearic acids approach palmitic in frequency of distribution of saturated fatty acids (Hilditch, 1956). Table 1 shows the average fatty acids of olive, palm, and jessenia oils. Table 2 shows US imports of olive and tropical oils.

Table 1. Average fatty acid content of olive. palm. and jessenia oils[1].

fatty acid	no. double bonds	no. carbon atoms	percent of total oil		
			palm	olive	jessenia
Saturated					
lauric	0	12	trace		
myristic	0	14	2	trace	
palmitic	0	16	43	11	13
stearic	0	18	4	3	4
Unsaturated					
palmitoleic	1	16		1	1
oleic	1	18	42	77	78
linoleic	2	18	9	8	3
linolenic	3	18	trace	1	1

1. Sources: Balick and Gershoff, 1988; Eckey, 1954; Hilditch, 1956; Lawson, 1985.

Table 2. U.S. imports of olive. palm, palm kernel and coconut oils. Oct-March 1990-91.[1]

	MT	'000 $	$/MT	% price olive oil
olive	48,701	107,994	2,217	--
palm	71,538	21,889	306	13.8
palm kernel	81,717	30,327	371	16.7
coconut	252,759	76,587	303	13.7

1. Source: USDA, 1991.

In the U.S., in terms of economic value, soybean oil, virtually unknown prior to World War II, now constitutes over 75 percent of all vegetable oils consumed (Weiss, 1983; USDA, 1990).

Palm oil

A product of ***Elaeis guineensis,*** the commercial African oil palm, palm oil is composed mainly of 35-40 percent palmitic acid, a lauric (saturated) fat similar to coconut oil, and 40 percent or more oleic, the main fatty acid in olive oil (Hilditch, 1956).

One method of refining palm oil is to degum with a phosphoric acid wash followed by alkali refining, water washing, and, finally, bleaching if the natural carotene pigments are to be removed and those fatty acids which hasten rancidity reduced. Subsequent fractionation steps can yield various products, each with its own characteristics and potential uses (Purseglove, 1985; Weiss, 1983).

Olive oil

Olive fruit is a drupe with a pulpy endosperm which, when ripe, is rich in oils (Bailey, 1949). It is the major cooking oil of most southern European countries and one enjoying increased consumption in the US. The composition of olive oil is predominantly unsaturated acids consisting mainly of oleic acid (70 to 85 percent); saturated acids include palmitic (7 to 15 percent) and stearic acid (1.4-2.4 percent) (Hilditch, 1956).

Olive oil was eclipsed for a time while Americans, especially those with elevated cholesterol, were told that polyunsaturated oils, especially corn, safflower, and canola, would lower their cholesterol which, indeed, they can. The drawback to the polyunsaturated oils is that they lower all forms of cholesterol including the high density lipids (HDLs) known as the "good" cholesterol. Beginning in 1985, however, a series of reports of studies comparing fats, saturated, monounsaturated, and polyunsaturated as well as diets low in fats and high in carbohydrate found that the monounsaturated oleic-acid-rich oils, most frequently olive oiL lowered plasma cholesterol and low density lipids (LDLs), but not HDLs (Baggio et al., 1988; Grundy, 1986; Grundy et al., 1988; Mattson and Grundy, 1985; Mensink and Katan, 1987). Olive oil lowered levels of LDLs at least as well as a low-fat high-carbohydrate diet, it did not raise triglycerides, and did not reduce HDL cholesterol (Baggio et al., 1988; Grundy, 1966; Mensink and Katan, 1987). (The best was yet to come. In a 1989 European study of Mediterranean diets, Renaud and de Lorgeril reported that the moderate consumption of alcohol, especially wine, but not polyunsaturated fats appeared to offer protection from heart disease among the French and Italians.)

To obtain olive oil, the most common process involves milling, that is, crushing and pressing (Eckey, 1954; Purseglove, 1968). Oil from the first pressing, possessing fewer free fatty acids and a more delicate flavor, is designated virgin grade (or, in some instances, the technical impossibility of being extra virgin) (Eckey, 1954; Robbelin et al., 1989). Good grades require no refining other than clarification obtained by settling or, in more mechanized operations, centrifuging and filtration (Weiss, 1983). The usual characteristics of olive oil include that it is fluid and clear at room temperature with color pale yellow through greenish-yellow. The color deepens and the flavor becomes less delicate as the grade departs from virgin (Eckey, 1954).

Jessenia

The genus *Jessenia* is native to the high rainfall areas of the lowland tropics of South America (Balick, 1988; Hodge, 1975). Its members grow in the Amazon Basin at or above flood level (Anon., 1976; Balick, 1988; Calvalcante, 1977) as well as the Orinoco Basin and Gulf of Paria regions of Venezuela (Ekey, 1954) and even on the slopes and valleys of the Colombian Andes at an elevation of 1800 meters (6000 ft.) although seldom above 1450 m (4800 ft) (DeLeon, 1958), thriving below 600 m (2000 ft) (Balick, 1988; Beckerman, 1977). The key cultural requirements for the genus are high rainfall with well-drained soils. The *Jessenia* are areca-like (smooth trunked, feathery leaved) palms with ringed trunk and a prominent crownshaft below the crown. The petioles have broad clasping bases; the leaves are borne at an upward angle, drooping only at the tips (Bailey, 1948; Balick, 1988; Beckerman, 1977). At maturity the sturdy trees can reach a height of 20 m (65 ft) or more (Balick, 1979), occasionally even more (Tomlinson, 1961) although Balick (1988) has observed naturally short trees in the wild.

The genus was established to honor Dr. Carl Jessen, professor of botany at Eldena, Prussia (Anon., 1960). From the beginning the taxonomic classification of *Jessenia* and the closely related *Oenocarpus* has been disputed (Anon., n.d.; Balick, 1979; Calvalcante, 1977; Dugand, 1961; Eckey, 1954; Glassman, 1965; Spruce, 1908). The confusion was resolved by Balick (1986) in his thorough revision of what is now known as the *Oenocarpus-Jessenia* complex of the Palmae (Balick, 1986).

Jessenia bataua (Martius) Burret, the species with the greatest commercial potential in this complex, has two subspecies, *J.b.* subsp. *bataua* with 40-90 pistilate flowers per panicle and the infelicitously-named J.subsp. *oligocarpa*--few fruited–with 3-54 pistilate flowers (Balick, 1986). The former is found in lowland areas of French Guyana, Brazil, Venezuela, Colombia, Panama, Ecuador, and Peru; the latter in the Valencia area of Trinidad plus Venezuela, Guiana, and Surinam. Over 100 local names are recorded for these palms. They include seje and pataua in South America and jagua, palma de jagua, and yagua in Trinidad. Both subspecies bear bunches of nutmeg-sized violet to purple fruit twice in the season between October and April (Beckerman, 1977; Calvalcante, 1977; Eckey, 1954). The 8 to 25 kg bunches (average 15-17.5 kg) are about 70 percent pericarp. This; pericarp contains 18 to 24 percent oil (Balick, 1979; Beckerman, 1977; Eckey, 1954; Markley, 1957) or an average of 3 to 3.5 kg oil per bunch of uncultivated fruit, extracted locally by boiling, maceration, and squeezing in a basket press (Balick, 1988; Uphof, 1968). This oil is in high demand in local markets (Balick, 1988; Calvalcante, 1977; Eckey, 1954; Schultes, 1974), and chemical analysis has confirmed Richard Spruce's opinion, voiced in a letter in 1854 to Sir William Hooker (Spruce, 1908), that it is the virtual equivalent of olive oil (Balick, 1979, 1988; Calvalcante, 1977; Eckey, 1954; Hardy, 1950; Jeffries, 1950; Uphof, 1968), even to its color–clear yellow with a slight greenish tinge (Anon., 1976; Balick, 1986, 1988; Eckey, 1954). Another curious quality of *J. bataua* fruit is that, unlike all other oil palms, the kernel contains less than 1 percent oil (Balick 1979; Eckey, 1954; Hodge, 1975; Markley, 1957).

In addition to the high-grade unsaturated oil, Beckerman (1977) notes that the fruit contains 8 percent dry weight protein; in 4 kg of fruit there are 72 gm fat and 32 gm protein, or slightly more than the protein in five eggs. The protein is remarkably well balanced. Analysis showed that it was superior in all essential amino acids except tryptophan and lysine (90 and 96 percent, respectively, of the FAO/WHO provisional scoring pattern) (Balick and Gershoff, 1988). According to Beckerman (1977), the fruit makes a substantial meal, especially if mixed with manioc. Dissolved in water, the fruit coating produces a refreshing drink that, if mixed with granulated yuca, can be quite filling (Jeffries, 1950). In addition, the spent pulp has been found to be an excellent poultry and swine feed (Balick and Gershoff, 1988).

Propagation of Jessenia: DeLeon (1958) writes that most palm seeds have thin seed coats that do not go into a state of dormancy. Rather, under unfavorable conditions, the embryos shrink and dry up. The length of time a seed will remain viable depends on the area to which the tree is native. Those trees from distinct wet-dry or warm-cool regions, or both, bear seed that remains viable for up to three months. Conversely, those such as ***Jessenia*** and ***Oenocarpus***, from areas of slight change in temperature and rainfall have seed viability of only two to three weeks. In consequence jessenia seed should be gathered, packed in a plastic bag with peat moss or damp newspaper, transported quickly, and sown as soon as possible (DeLeon, 1958). Seed were germinated by Jordan (1970) in two lots with 99 and 80 percent success. Balick (1979) reported that *J. bataua* took an average of 20 to 40 days to germinate. In addition, he said that the seeds, if cleaned of epicarp and mesocarp and kept moist and warm, will remain viable for up to six weeks. Soaking the seed for 30 minutes in 50°C water (or one week in cool water) resulted in 98 percent germination with more precocious leaf appearance at 52 days (Balick, 1988).

In the wild, trees bear 1 to 3 panicles, 2 to 3 being most common (Balick, 1986, 1988). Selections for more panicles should bring the reliable number to 2.5 or more per tree (Balick, 1988). The flowers are insect pollinated with no lack of volunteers (Balick et al., 1988). In the wild, trees reach bearing age at 7-10 years. Balick (1988) believes that, like the African oil palm, domestication can halve this time. Jessenia has 100 percent production in years 15-42 (7-10 more an oil palm), then drops off sharply (Balick, 1988; Purseglove, 1972). Jessenia, like most palms, has a symbiotic relationship with vesicular-arbuscular mycorrhizae (VAM). Because VAM are found in most native soils, it is only nursery-grown jessenia that may be negatively affected by the absence of VAM in potting mix (St.John, 1988). Consequently, if nursely grown, it is advisable to inoculate the mix with VAM.

Assuming the average fruit panicle bore 10.4 kg of fruit and the mature fruit averaged 8 percent oil, 100 bearing trees would yield approximately 130 kg (285 lb) of oil per tree (Balick, 1988). At 216 trees per hectare (which allows for intercropping), nearly 400 kg (880 lb) of oil could be anticipated. The oil weighs 7.63 lb/gallon (15.26 oz/pint), so 880 lbs would yield over 900 pints, processed, packed, and wholesale marketed for an upscale consumer at, presumably, US$1 or more (Table 3). In August, 1991 average grade olive oil retailed in the US for $5.59 per liter.

Table 3. Average unit value of U.S. olive oil imports ($/MT)[1.]

Year	1984	1986	1988	1990
Price	1353	1537	1632	2047
$/lb.	0.514	0.697	0.740	0.928

1.Source: US Bureau of the Census, 1991.

Processin. Jessenia processing usually consists of harvesting, piling, and covering with leaves or a plastic sheet overnight to further ripen the fruit. They are then dumped into a large vessel of approximately 50°C water and soaked for 2-3 hours. They are then decanted into a smaller pot while the large one is again filled with water and heated to just below the boiling point and removed from the fire. The fruit are placed in this pot to split the epicarp, then removed and pounded in mortars to separate the flesh from the seed. The whole is sifted in a half-inch screen sieve, the seeds drop through, and the rest is transferred to a basket press. Pressure is applied and the oil is expelled pigmented water. The light green to yellow clarified oil is then bottled (Balick, 1988).

Intermediate technology substitutes a simple hydraulic hand press for the basket. The result is a significantly greater percentage of oil (Balick, 1988).

For the best oil extraction, a small oil processing mill similar to that described by Blaak (1980, 1988) used in a West African palm oil mill is necessary. The fruit is stripped from the panicle (often before transportation to the mill), then steamed and digested to loosen the mesocarp. The fruit are sifted to remove the seeds, reheated, and pressed. Next the oil is clarified to remove emulsified water, then bottled. (Further details are available in the FAO plant production and protection paper, number 88, 1988: ***Jessenia*** and ***Oenocarpus:*** Neo-tropical.

Oil Palm Worthy of Domestication, by M.J. Balick.) According to Blaak (1988) and based on the figures for the seje (jessenia) oil mill in rural Colombia, the approximate cost (extrapolated from the 1980 figures assuming about 2.5 percent annual inflation) is about $22,000 for the imported press and digester plus engine and an additional $15,000 for shed, foundation, labor, transport, and locally obtainable equipment.

While no one is likely to get rich, this would be an excellent way to supplement the incomes of a community.

Climate and soils

Native: The areas where ***Jessenia bataua*** is native are characterized by high temperatures with no appreciable seasonal variation. Growth coincides with the rainy season. Soils are highly weathered with low mineral reserves, well drained, usually with low cation exchange capacity. As is typical of many soils in the humid tropics, bases are quickly recycled by forest vegetation. In general, there are no more than 90 cumulative days a year of dry weather (Anon, n.d.; Young, 1976).

Caribbean: Among the islands in and countries surrounding the Caribbean, both size and elevation are important for attracting rain. These qualifications rule out an island such as Antigua which, despite good and diverse soils, covers only 280 km^2 and does not have sufficient elevation, particularly in the east, to attract much rain (Anon., 1960; Hardy, 1950). The same is true for Barbados (Anon., 1960; Poynter, 1986). Among the larger islands of the Caribbean, geologically similar Puerto Rico and Jamaica (Hardy, 1950) have volcanic mountains surrounded by limestone plains (Anon., 1960; Bonnet, 1950; Jeffries, 1950; Meyerhoff, 1950). Both islands. Jamaica especially, have areas of tropical rainforest (Anon., 1960; Meyerhoff, 1950).

In the major French islands, Martinique, while somewhat smaller than Guadeloupe, has higher elevations with more remaining forest (Anon., 1960; Moulin, 1950). Geomorphically, both islands benefitted from the 1902 explosion on Martinique of Mt. Pelee and the subsequent volcanic ash and dust deposits that replenished soil nutrients in land under sugarcane cultivation (Anon, 1960; Stehle, 1950). The remaining volcanic Windward and Leeward islands are also relatively small. Dominica (750 km^2) and St. Lucia (620 km^2) each have notable elevations (1447 m and 950 m, respectively) with fertile soils derived from andesite and basalt (Anon., 1960; Hardy, 1950; Rodrigues, 1950). In general, the dry period in the eastern Caribbean lasts from mid-January to mid-April or early May (90-120 days) (Anon., 1960).

Trinidad, has a wide variety of soils and elevations, the wetter northeast especially. It is a geologic continuation of Venezuela (Anon., 1960; Hardy, 1950) and one of the areas where ***J. bataua*** subsp. ***oligocarpa*** is native, thus a good candidate.

DISCUSSION: ESTABLISHING JESSENIA

The greatest initial problem in the cultivation of ***Jessenia bataua*** would be the selection of seedlings and progeny for highest panicle number, seed oil content, plant vigor, and, if possible, shorter stature. If the time is brief between collection and sowing of seed, good germination is almost assured. An investment in time and travel would be necessary to ascertain qualities of soil, soil fertility, drainage, and rainfall to nearly duplicate J. *bataua*'s natural habitat or to compensate for any shortcomings.

In addition to the time from germination to planting out the seedlings, there would be a lag between the time of planting and the first harvest of sufficient quantity to warrant marketing the oil, as well as a need for processing and packing facilities. Because of these inevitable and unavoidable delays, cultivation of jessenia most likely would require cooperation and economic contributions from government or private investors or both. Once supply and processing were assured, the oil would require good marketing, stressing the product's many desirable characteristics and directed to upscale consumers--in other words, "boutiquing" the product. Previous campaigns aimed at similar markets have resulted in demand for such products as yogurt, safflower and canola oils, kiwi fruit, alfalfa and other sprouts, and almost any sort of fish imaginable. Jessenia oil has the same potential to carve out a niche in the lucrative upscale markets of Europe and North America.

ADDENDUM

Plantings of *Jessenia bataua* have been established at CEPLAC (Una) near Itabuna, Bahia, Brazil and at CEPATU, Belem, Brazil coordinated by CENARGEN/EMBRAPA (the Brazilian National Germplasm Conservation Program) (Balick, 1988). Those interested in more information on current seed sources might also write to Dr. Michael J. Balick, Director and Philecology Curator of Economic Botany, Institute of Economic Botany, New York Botanical Garden, Bronx, NY 10458-5126 USA.

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