RESEARCH NOTE

# SEJE: AN OIL-RICH PALM FOR DOMESTICATION

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'It is an excellent thing to show the diversity of ways to make Oyl. That if Olives should ever be scarce, yet we might know how to draw Oyl from many kinds of fruits and seeds.'

John Baptiste Porta: *Natural Magick* (1658).

No plant scientist can categorically say how many species of plants now exist in the world. Estimates vary between 250 000 and 500 000. Botanists whose research concerns tropical floras in often poorly-studied regions tend towards the higher figure. Whichever calculation is accepted, however, it represents an amazingly extensive and complex array of organisms the study of which, in many respects, has just begun.

In recent years, the multifarious dangers that may result from the inexorably growing extermination of thousands of species have been recognized, and conservationists have insistently called attention to the incalculable losses that this race towards extinction will undoubtedly inflict on the future of human existence. How many plants with properties that man might tend to his needs are disappearing even before they can be studied? The number surely is very high.

In the early years of this century, Sturtevant (see Hedrick, 1919) searched the literature for every report of plants that man has used as food, even fleetingly in times of famine and dire need. He found references to nearly 3000 species – a surprisingly small percentage of the world's flora. Of these 3000 species, only some 150 have ever been of sufficient importance to enter the world's commerce. And man, as a global animal, is today nourished by a meagre few: 12 or 13 of these 150 species: rice, wheat, maize, sugar cane, sugar beet, common bean, soyabean, peanut, white potato, sweet potato, tapioca or cassava, banana (including the plantain) and coconut. These plants literally stand between the human race and its disappearance through starvation. All are adaptable to systems of agriculture, and it is man's great achievement in discovering agriculture that has led to his dependence on so few species of food plants.

It is probably logical to conclude that man, over the hundreds of thousands of years of experimentation, has thoroughly explored the food value of his ambient vegetation and that, consequently, it is inconceivable that he has missed finding any wild species of high nutritional potential. Yet we are now coming to realize that there is indeed a limited number of plants – particularly as sources of food – that, if amenable to domestication and agricultural practices, could, especially with modern techniques, make significant contributions to contemporary human living.

It has long been recognized that the world's food supply is inadequate. Furthermore, it is known that the vertiginous growth of the human population is daily complicating the problem of feeding. In addition to this pressing scarcity of food, one must consider the serious insufficiency of proteins and fats or oils in the diet in many of the densely populated and developing nations. Nutritionists state that 20%-30% of an adequate diet should be in the form of oils or fats. Proteins and fats usually are much more costly than carbohydrates – one of the reasons for their insufficiency in large areas of the globe, especially in the tropics.

Several avenues may be followed to alleviate this scarcity, particularly in regard to sources of fats and oils. First: more use of animal sources might be made locally and on a limited basis. Second: the acreage of oil-rich crops could be enlarged. Third: the yield of presently available major oil-rich plants might be increased through modern techniques, such as se-

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lection and genetic engineering. Fourth: new vegetal sources could be sought and domesticated.

The first of these methods is the least promising and may often be impractical, especially in under-developed countries, in as much as the production of fats and oils from animals is comparatively expensive; and since the production of edible oils from plants has recently increased at the expense of animal fats, it is clear that the Plant Kingdom must be the better and less costly source of these products. The second is being applied in many regions: witness the recent extraordinary expansion in the planting of the African oil palm, *Elaeis guineensis;* but even this method may often be limited by various conditions. The third approach is likewise under way with major oil-rich crops: soyabean, coconut, peanut and others. The fourth has recently received increased attention and has resulted in the domestication of new oil-rich crops: aceituno (*Simaruba glauca*), crambe (*Crambe abyssinica*) and others.

One of the richest oil-yielding families is the Palmae. Amongst the many palms that yield a variety of oils, there is one group native to the humid tropics of the Americas of outstanding promise in having candidates for domestication as new sources of edible oils: these are various species in two allied genera – *Jessenia* and *Oenocarpus*. The two genera are so closely related that they hybridize in nature, and their oils are chemically rather similar; in composition they are now known to be very close to olive oil.

When I began my field work in the Colombian Amazon in 1941, I was occasionally invited to stay at the few mission stations in that remote region. The missionaries were all from Spain. Frequently they prepared salads and poured on them a yellowish oil. One day, I remarked how difficult it must be to get olive oil in such a remote region, the rivers of which are not navigable because of waterfalls and rapids. Their reply was: 'It is not olive oil; it's seje oil'. It looked and tasted just like olive oil, and at that time I decided that the seje palm was something to investigate; for, if it is possible to separate a Spaniard from his olive oil, I reasoned that the substitute must be of a superb quality!

During the following 47 years, my field work in the north-west Amazon was focused on rubber-yielding species and biodynamic plants used by the natives as medicines, poisons or narcotics, and it was impossible to devote much attention to these two genera of oil palms. But I never forgot seje oil, and I lived in hopes that one day I might be instrumental in encouraging a study of these trees as potential new crops for the humid tropics.

Eventually, a promising graduate student, who came to study tropical economic botany under my direction at Harvard University, indicated that for his doctoral dissertation he would like to undertake research on the biology of a wild plant of promise as a potential new crop for a region like the Amazon. Immediately thinking of the seje palm, I suggested it as a topic for his dissertation. He accepted the suggestion with open enthusiasm.

Pursuing field studies for his Ph D thesis, Dr Michael J Balick spent a total of 14 months in the forests of Bolivia, Brazil, Colombia, Ecuador, Peru, Trinidad and Venezuela, investigating the one species and two subspecies of *Jessenia* and the eight species and four subspecies of *Oenocarpus*. Field work over such a long period and in regions often difficult and costly for travel, requires appreciable expenditure. Financial support for the initial phases in Colombia was made possible by the Colombian Centro de Desarrollo Integrado, a governmental development institution engaged in domestication and utilization of new crops, and its director, Dr Paulo Lugari C; and by Dr Mariano Ospina H of the Colombian Research Corporation, a private foundation interested in the study of plant resources in Colombia, both were in a collaborative research programme with the Botanical Museum of Harvard University. Further field work in other countries and follow-up laboratory and herbarium studies were supported by grants from the National Science Foundation, the Lawrence Travel Award and the Anderson and Atkins Funds of Harvard University. This support is encouragingly indicative of the growing interest in the potentialities of research in economic botany.

Dr Balick has continued investigation of oil-rich palms. Each visit to the American tropics turns up additional information or new discoveries, such as the unexpected finding of a curious pot-bellied form of *Jessenia* in the Pacific coastal region of Colombia! And recently, he saw a pile of *Jessenia* seeds for sale as love amulets in a native market in La Paz, Bolivia, where, of course, *Jessenia* does not grow (at 3350 metres of altitude). Questioning the Indian vendor on the provenience of the seeds, he learned that they had come from the Beni region in Amazonian Bolivia. *Jessenia* had never been collected in Bolivia. When Dr. Balick went to the Beni, he found extensive stands of wild *Jessenia* in the forests. Here is an excellent example of one of the many practical advantages of ethnobotanical curiosity!

It is almost axiomatic that a wide knowledge and understanding of a wild plant in its natural habitat is desirable in any serious and successful effort at domestication. It is now usually possible to get this information, but it has not always been so. The British, for example, were hampered by several unfortunate drawbacks when in 1877 *Hevea brasiliensis* – the world's major rubber tree – was taken from the Amazon and introduced into the Asiatic tropics. These drawbacks were due partly to the lack of familiarity with the ecology and biology of the plant in its native habitats.

Thanks to Dr Balick's investigations, we now have a large body of information on the classification, ecology, biology, ethnobotany, oil chemistry and nutritional aspects of these promising palms – information that will be of inestimable value when plantations for commercial production of the oil are initiated.

Species of *Jessenia* and *Oenocarpus* have never been cultivated. In fact, very little of the oils from them has ever entered commerce permanently. Almost all extraction and use of the oils has been limited to peoples in indigenous societies in the forests. In 1939, Brazil exported 14 870 kilogrammes. During the Second World War, this exportation reached a high of 214 674 kg, but by 1949 it had fallen back to 24 656, partly because the oil was collected destructively by felling the palms. In the late 1940s, most of the total imports came to New York, where the oil was used in soap manufacturing and the cosmetics industry. All of the production, however, came from wild trees in a haphazard forest industry, mostly in the eastern part of the Amazon Valley.

Of the members of the *Jessenia* – *Oenocarpus* complex, the most important insofar as use amongst the natives is concerned and the most promising for domestication is *Jessenia bataua*. Naturally, however, once a programme of domestication is initiated, germplasm of all of the other species and subspecies will undoubtedly be desired for genetic work.

*Jessenia bataua* is known in Bolivia as *majo;* in Brazil as *pataua;* in Colombia as *coroba, milpesos* and *seje;* in Peru as *ungurahuay;* and in Venezuela as *jagua* and *seje*. It grows in both well-drained upland forests and in swampy lowlands from sea level to about 900 metres and in Panama, the Chocs of Colombia, the Guianas, throughout the Orinoquia and Amazonia and in Trinidad. When it grows in boggy land, it often occurs in almost pure stands. The density of these wild stands often reaches 450 trees per hectare but sometimes it can be much greater.

The tree may attain a height of 25 metres in the forest. A strikingly stately palm, easy to recognize with its feathery leaves, it bears large fruiting panicles with up to 1000 purple-black fruits, the mesocarp of which may contain up to 50% of oil. An average panicle in fruit weighs approximately 14.5kg of which 10 kg is fruit. A study of 100 trees in the wild indicated that 128.3 kg. of oil was produced. It is not uncommon for trees in the forest to bear five panicles at one time; cultivation, of course, probably will increase the number of panicles and the density of fruit; and it can be expected that cultivation may allow the palm to come into fruit in seven or eight years instead of the eight or ten years which in the wild state is apparently normal.

The natives take advantage of these fruits in several ways: the mesocarp is consumed directly; a milk-like beverage is made from the pulp; the oil is extracted and employed for a number of culinary purposes. The mesocarp is also an excellent animal feed.

The oil of *Jessenia bataua*, with some 78% of oleic acid and 13.5% of palmitic acid is chemically very similar to olive oil (both with approximately 75%-80% of oleic acid), except that olive oil has three times as much linoleic acid. Other fatty acids are present in very minor amounts.

Protein analyses indicate that the limiting amino acids are tryptophan and lysine at 90% and 96% of recommended levels, meaning that seje protein is better than the proteins of most grains and legumes and comparable in quality to good animal protein. The oil does not suffer rancidity even without chemical preservative for many months in the hot, humid Amazon environment.

Edible oils provide energy in the diet and play an essential role in metabolism as transporters of fat-soluble vitamins such as A, D, E and K and in maintaining certain tissues of the body. Since production of edible oils from vegetal sources has greatly increased over that of animal fats, it is obvious, as already mentioned, that the Plant Kingdom must be the better and less expensive source of these food elements. It was observed, during Dr Balick's

← *Figure 1.* Jessenia bataua *at the edge of a gallery forest. Las Gaviotas, Intendencia del Vichada, Colombia. Photograph: Balick.*

*Figure 2. Fruiting panicles of* Jessenia bataua *in primary forest. Manáos, Estado do Amazonas, Brazil. Photograph: Balick.*

← *Figure 3. Fruits of* Jessenia bataua. *Mitú, Comisaría del Vaupés, Colombia. Photograph: Balick.*

field studies, that daily consumption of *Jessenia* products during the fruiting season 'had a profound effect on the local inhabitants' of the Colombian Comisaria del Vaupes. 'They gained weight, appeared healthier with more endurance' and reported fewer respiratory infections'. This observation has been confirmed by other field researchers.

Seje oil is a product particularly appropriate for warm, humid tropical regions where transportation may be slow and intermittent, since it is so resistant to rancidity. Consequently, the palm could be exploited either in large, commercial plantations or in small family plots; furthermore, since it often occurs in extensive wild stands, it might also be advantageously used by indigenous peoples or settlers without investment of funds for cultivation. It is, however, a resource that has often suffered from uncontrolled felling for the harvesting of oil; and in view of this past occurrence in sundry areas of the eastern Amazon, strict methods of conservation should be considered, if wild stands are put into production.

There are several economic reasons to support the belief that *Jessenia* will be a success once plantations are set up to produce large quantities of oil. First: the humid forested tropics are in desperate need of export products of relatively light weight and high monetary value. Second: one of the crucial shortages in the diet of much of the human race today relates directly to the availability of edible oils. Third: olives must be harvested by hand, and the cost of labour is constantly rising in the major olive oil-producing regions. Fourth: there are by-products of the seje palm which, though minor, might assist its exploitation. The oil is widely esteemed in traditional medicine for treating a number of respiratory ailments, and the mesocarp, after expression of the oil, provides an excellent animal feed, comparable in protein to soya beans.

Scientists and mechanical engineers at Las Gaviotas in Colombia have devised inexpensive and efficient mechanical methods for extraction and subsequent preparation of seje oil. The process involves several stages: selection of appropriate fruit from the panicle; sterilization (to inactivate enzymes that might cause deterioration of the oil through rancidity or lipolysis); digestion (breaking of the oil-rich cells of the mesocarp; pressing (use of an hydraulic hand press that can process approximately 660 pounds of mesocarp an hour); clarification – separation by heat of the water and fibre from the oil in the last step. The elemental mechanics of seje oil production of a commercial basis have, therefore, been resolved.

Even though we now have sufficient information on the biology of *Jessenia* to ensure successful domestication of the palm, there is much more to do if we are to take full advantage of this promising source of edible oil. Projects are now under way to further scientific understanding of seje, amongst which a particularly promising one has recently been set up by the Caja de Credito Agraria (the Colombian Agricultural Credit Bank) in the extensive area under its control in the Colombian Amazonia.

Mycorrhizal needs are known to be very important for normal growth of American palms. If seje is taken out of its usual range, it may not have available the proper mycorrhizal species, and this could result in slow or abnormal growth. A project is now under way to study the mycorrhizal biology of *Jessenia*: in plots in Peru and Brazil, and in greenhouses in California and New York innoculations are being made to further our knowledge of this aspect of the life of the palm. Cryogenic experiments are likewise being carried out in a project to ascertain the long-term storage potential of callus tissue for use in tissue culture. These and other forward-looking investigations will contribute to the scientific establishment of plantations of seje and will go far towards making *Jessenia bataua* one of the outstanding new crops for the humid tropics.

It is indeed 'an excellent thing to show the diversity of ways to make Oyl'.

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