CUCURBIT SEED AS POSSIBLE OIL & PROTEIN SOURCES

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INTRODUCTION

Oils are necessary in the diet as a source of non-saturated fatty acids, in order to give flavor to foods, as sources of fuel for the body, and in addition, are used in the kitchen as a cooking medium. The problem of interest here is how to produce the oils needed at the level of the individual household, in the tropical household. This problem has several aspects of interest.

On a small scale, animal fats are more easily obtained from small animals than plant fats obtained from plants. Animal fats are fairly stable, can be used one or two weeks or more even without refrigeration, and are fairly well accepted. They do not contain sufficient non-saturated fatty acid (palm oils, however, are an exception to this rule.) Plant fats are therefore more useful to the body from a nutritional standpoint, but they are less stable, and easily turn rancid. Most plant oils occur as stored materials in seeds. To use the fats it is often necessary or at least desirable to remove the seed coats from the seeds. In order to obtain the nutritional value of the non-saturated fatty acids it is not necessary to extract the oils from the plants. Thus, the kernels can be used in many different ways. A convenient form to use the fats of some seeds is as a vegetable curd. This is prepared by grinding the seeds in water, filtering, and precipitating the protein with an appropriate agent such as lime juice, vinegar, or epsom salts. Most of the oil as well as the protein is extracted and precipitated, the former by occlusion in the protein.

In the hot humid tropics there is often a shortage of oil in the diet, or cooking oil in the kitchen. It is difficult to mature many of the most typical oil crops during the rainy season. While large scale techniques for extracting the oil are available in some cases, they are not necessarily the best for the small scale everyday needs of the tropical household. There is a need for appropriate crop sources of oil in the humid tropics, and for techniques for their use.

A suitable crop for oil production on a small scale should be an annual, or a perennial that produces during the first or second year. The oil-producing fruit or seed should be available year round, or, as an alternative, the seed should be storable so that oil can be produced year round. It is also very useful if the seeds that are sources of oils are also good sources of protein.

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PRINCIPAL TROPICAL PLANT OIL SOURCES

In the tropics fats are obtained from the seeds of numerous plants, many wild or produced on only a local scale. The most important plant sources of oil in the tropics are given on Table 1. In terms of production per unit area, the oil palm, *Elaeis guineensis* Jacq. outproduces all other species as an oil source. These oils can be extracted at the household level, and are extremely useful. Palms need space and time to grow, of course, an thus are not convenient crops for the small household.

Table 1. **PRINCIPAL PLANT SOURCES OF OILS IN THE TROPICS AND THEIR LIMITATIONS FOR SMALL SCALE USES.**

Source of Fat	Limitations
African Oil palm	Awkward for small scale production
Coconut Palm	Awkward for small scale production
Soybean	Tropical varieties needed; Suitable in many areas
Peanut	Suitable in many areas
Safflower	Requires dry climate
Sesame	Needs dry climate
Sunflower	Pollination often poor in tropics
Flax	Not adapted to the tropics
Castor bean	Not suitable for household production
Cotton seed	Not suitable for household production
Okra	Under investigation, probable small to large scale value

The soybean, peanut, and possibly the winged bean are suitable sources of high quality cooking oil, but are very difficult to extract on a small scale. They are all excellent as sources of non-saturated fatty acids in the diet. Cotton and okra seeds are other possibilities. Cotton seed is seldom produced on a household scale, but okra seed is often available on the small farm and can be considered a potential source of oil. In both crops the presence of gossypol or related substances in the seeds limits current use. However, lines low or free of gossypol are also feasible.

CUCURBITACEOUS SEEDS AS OIL SOURCES

The uses of cucurbit seeds as sources of oils and proteins have been reviewed by Jacks, et al. (1972). After the hull is removed, cucurbit seeds contain about 50 percent oil and up to 35 percent proteins. Most of their oil is made up of non-saturated fatty acids, thus of high nutritional values. Conjugated fatty acids among some cucurbit oils make them highly useful as drying oils. [I.e. they combine readily with oxygen to form an elastic, waterproof film. Ed.] The proteins, on the other hand, are principally of the globulin type, and are deficient in lysine but also in sulfur-bearing amino acid. Protein efficiency ratios of about 30 to 70 (that of powdered skim milk is 80) have been measured. The PER improves with addition of lysine.

The uses of cucurbit seeds for their high protein and oil content have many precedents. In tropical Africa two species of *Telfaria* (see Table 2) are used for their large oily seeds. *Hodgsonia*, a perennial vine with large, fatty seeds, has been domesticated as an oil source in China (Chien, 1963), where it is known as the lard fruit. *Cucurbita mixta* was domesticated in pre-Colombian Mexico and Central America chiefly for its seeds, sources of protein and oil. The nutritive value of pumpkin seed is improved when the meal is mixed with soy flour or supplemental lysine (Craveola & Cervantes, 1965). In West Africa, the seeds of *Citrullus lanatus* are used as commercial sources of oil (Omidiji, 1977). These and seeds of *Cucumeropsis edulis* and *Lagenaria siceraria* are used in melon soups for their oil and protein content. Important species used for oil are given in Table 2.

Table 2. **SPECIES OF CUCURBITACEOUS PLANTS OF POSSIBLE USE AS SEED OIL SOURCES IN THE TROPICS.**

Species	Common Name	Notes
Benincasa hispida	wax gourd	Appears very suitable for the hot, humid tropics. Seeds seldom used for food.
Citrullus lanatus	watermelon	Selected varieties. Definite preferences for dry climate, a West African species.
Cucumeropsis edulis	egusi	Definite preference for dry areas. Used in West Africa.
Cucurbita maxima	squash	Domesticated chiefly for its flesh, principally temperate zone.
Cucurbita mixta	squash	Domesticated and used for edible seeds. Dry area.
Cucurbita moschata	pumpkin	Seeds edible, but this species is grown chiefly for its flesh.
Cucurbita pepo	squash	Widely used for its fruits and to a lesser extent for its seeds.
Hodgsonia macrocarpa	lard fruit	Recently domesticated in China, subtropical.
Lagenaria siceraria	bottle gourd	Seeds edible, but used chiefly in West Africa, prefers dry conditions.
Luffa acutangula	angled luffa	Seeds and seed oils very bitter, poisonous.
Luffa cylindrica	sponge gourd	Seed and seed oils bitter, may be poisonous.
Telfairia occidentalis	oyster nut	Seeds roasted or rendered, wet tropical Africa.
Telfairia pedata	oyster nut	Seeds roasted or rendered, dry tropical Africa.

As a general rule, cucurbitaceous plants prefer dry climates, and many are so riddled with disease in the humid tropics that production is impossible. When there is a pronounced dry season it is often possible to grow the vines, produce the fruits, and store the seeds for use as needed. A few species useful for their seeds can be grown in the humid tropics as shown by our experience in Puerto Rico. The most successful species are *Benincasa hispida*, the wax gourd, and *Cucurbita moschata*, the tropical pumpkin. If fruits are carefully protected from excess moisture, *Lagenaria siceraria*, the bottle gourd, can also be grown. In Table 3, experience at Mayaguez, Puerto Rico is summarized.

Table 3. **RELATIVE YIELDS AND PROBLEMS IN MAYAGUEZ, PUERTO RICO OF CUCURBITACEOUS SPECIES AS SOURCES OF SEED DURING TWO SEASONS OF THE YEAR.**

Species	Winter	Summer
Benincasa hispida	Excellent yields	Excellent yields, fruit rots
Citrillus lanatus	Low yields	Complete failure
Cucumeropsis edulis	Low yields	Complete failure
Cucurbita mixta	Fair yields	Complete failure
Cucurbita moschata	Good yields	Fair yields
Lagenaria siceraria	Excellent yields	Fair yields
Luffa acutangula	Fair yields	Fair yields
Luffa cylindrica	Fair yields	Fair yields
Telfairea occidentalis	Low yields	Low yields

Benincasa hispida is perhaps the best of the cucurbits as a source of seed oil for the hot, humid tropics. It can be produced at any season of the year. During the rainy season the fruits are susceptible to rotting. They can be protected by growing the vines on trellises or by placing thick but porous supports between the fruit and the wet ground. The fruits are very large, and are very seedy. If the fruits are sound, they can be stored for many months, even a full year, until used. Or, the seeds can be removed and dried, as later discussed. Per hectare yields of these seeds have been estimated in our fields as 500 kg/hectare.

Seeds of cucurbits can usually be readily separated from the stringy pulp to which they are attached. Sometimes a light fermentation for 24-72 hours of the wetted seeds is useful to clean the seeds of pulp. The cleaned seeds are carefully washed and can then be processed for use or dried for storage.

Fresh, wet seeds sometimes are chewed without further processing. They also can be toasted, with or without light salting. Or, they can be cooked into soups with or without removing hulls. Naked or almost naked seeds of *Cucurbita pepo* are especially desirable for such uses because of the lack of seed coat. This means, also that the concentration of oil and protein are very high, and the concentration of fiber is very low in the edible part.

If the seeds are to be stored, they should be carefully dried in the sun or at lowest settings in an oven. Stored seeds retain most of their nutrient content for years and are convenient for rapid later use. The seeds can then be cooked with or without dehulling, or can be ground into a nutritious oily meal.

At our own laboratories we have emphasized the preparation of vegetable curds from cucurbit seeds as an unique method of using the protein and oil. In table 4, the results of tests in Mayaguez, Puerto Rico are summarized.

Table 4. **CHARACTERISTICS OF CUCURBIT SEEDS AS A SOURCE OF VEGETABLE CURD.**

					Curd Characteristics		
Species	Seed Color	Extraction Problems[1]	Best precipitating agent	Color	Texture	Taste	Rating[2]
Benincasa hispida	white	FC, PS	Vinegar	light tan	spongy	mild	5
Citrillus latatus	cream	FC	$MgSO_4$	cream	sticky	neutral	5
Cucumeropsis edulis	white		$MgSO_4$	lt. green	smooth	oily	4
Cucurbita mixta	white	FC, O	$MgSO_4$	lt. green	smooth	neutral	4
Cucurbita moschata	whitish						
Lagenaria siceraria	tan	FC	$MgSO_4$	light tan	very smooth	mild	4
Luffa acutangula	black	FC	$MgSO_4$	grey	smooth	bitter	1
Luffa cylindrica	white	FC	$MgSO_4$	lt. green	smooth	bitter	1

[1]Extraction problems- FC= Fine Curds difficult to filter. PS= Poor separation of curds. O= Oil impedes separation.
[2]Rating- 1=lowest value, 5=highest value.

All of the cucurbits with the exception of the *Luffa* species produced a very satisfactory vegetable curd, as good as tofu from soybeans. These curds were rich in protein and oil and contained no more than minor and insignificant traces of the seed coat. However, the vegetable curds are usually very fine and difficult to separate from the whey by filtration. In one case, *Benincasa*, the use of vinegar or lime juice yields a better, more manageable curd.

We consider these results preliminary but very promising. Studies of the protein and oil content of the *Benincasa* seeds and curd are planned.

Although hand presses can be used to remove oil from cucurbit seed, we consider these and solvent based practices unsuitable for the small household. We have not yet found a satisfactory solution to the need to produce cooking oil from the seed by small scale household processes.

Thus, preliminary consideration of cucurbita seeds as sources of vegetable oils are promising. Extensive further studies are needed to select appropriate species and varieties, and to develop appropriate techniques at the household level.

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