

VARIATION IN SEED WEIGHT FROM VARIOUSLY-SEEDED
FRUITS OF COSTA RICAN RAINFOREST *MUCUNA*
MUTISIANA (LEGUMINOSAE) VINES

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Corcovado National Park, seed, ojo de buey, urtication, legume.

ABSTRACT

Mucuna mutisiana (Leguminosae) is a common large woody liana (vine) of secondary successional rain forest in Corcovado National Park, southwestern Costa Rica. It bears large fruits that are usually 2-seeded (range, 1-3). Average seed weight for 2-seeded fruits was 9.08-6.86 g, and seeds from 2-seeded fruits always averaged greater or the same in weight as did seeds from 1- and 3-seeded fruits from the same plant. Each of four of the eight crops had seeds that were significantly different in weight from the seeds in the other seven crops. The lightest and the heaviest seeds in an entire crop were almost always in 2-seeded fruits. Since there is virtually no seed predation or animal seed dispersal for *M. mutisiana*, these crop parameters have been evolutionarily produced by other forces. All raw seed weights are included with this paper.

It is commonplace for legume fruits to contain variable numbers of seeds per fruit within a population or even within a single fruit crop of a parent plant. Legume seeds also vary in weight within a population or plant (e.g., Thompson 1984). Part of understanding this variation requires a knowledge of how much it occurs among various legume species (Janzen, 1977a, 1977b, 1977c, 1978, 1979, 1982a, 1982c). Here I ask how mature seed weight varies among plants and among 1-, 2- and 3-seeded fruits in the large woody rain forest liana (vine) *Mucuna mutisiana* (Faboi-deae, Leguminosae).

M. mutisiana is most widely known as one of those seeds that are encountered in tropical beach drift (Gunn and Dennis 1976); such seeds originate from vines growing over streams and riverbanks within the rain forest. Since these seeds are carried to a beach habitat where they do not grow, they do not contribute to future generations of the parental population. The Costa Rican vernacular names for *M. mutisiana*, "ojo de buey" and "ojo de venado", are indiscriminately applied to

seeds of *Mucuna* spp. and *Dioclea* spp. *M. mutisiana* is an occasional indigenous member of 5-20-m-tall secondary successional vegetation that occupies old fields cut out of lowland coastal rainforest in Corcovado National Park, Osa Peninsula, Puntarenas Province, southwestern Costa Rica. The large woody vine climbs as high as 20 m on the crowns of other plants, and its fruits and bat-pollinated flowers are born on long pendant stems below the vine canopy, as has been described for the similar *Mucuna andreana* (Baker 1970). The clusters of 1-5 large fruits (7-15 cm long, 5 cm thick, rugose, woody) are conspicuous but generally ignored (or avoided) by vertebrates, apparently owing to the thick fur of extremely urticating hairs that covers the outer surface of the maturing and mature fruit. When ripe, the woody and fibrous fruits gradually dehisce along one suture through drying. The rock-hard flattened-spheroidal seeds (15 mm thick by 25 mm diameter, gray, smooth) fall to the ground. In contemporary habitats in Corcovado, the seeds appear to be moved (dispersed) almost entirely by water and erosion, though rodents may occasionally move them as well. They may remain hard and dormant for tens of years in dry or moist soil. The seed germinates within several days if the seed coat is cut and the seed placed in or on moist soil (e.g., Janzen 1976).

Materials and methods

Large *M. mutisiana* plants with crops of several tens of mature and dehiscent fruits were collected from a chosen plant; sample sizes per plant were thus determined building site at Llorona and the main park headquarters at Sirena, Corcovado National Park (March 1977). Plants were chosen to be at least 30 m apart, so as to avoid treating parts of the same clone as genetically different individuals. All fruits were collected from a chosen plant; sample sizes per plant were thus determined by fruit crop size. Within a sample, seeds were pooled according to whether they were from 1-, 2-, or 3-seeded fruits (no fruits had more than three seeds). A few seeds were distorted or damaged and both these seeds and the remaining seeds in their fruits were discarded; 97 percent of the fruits contained only fully-formed perfect-appearing seeds. A hundred of these seeds had their seed coats filed through and were planted in moist greenhouse soil; all germinated.

The seeds were weighed to the nearest 0.01 g in their dry but dormant (living) condition. Breaking and grinding a sample of 10 seeds, and then oven-drying them, yielded a value of 6-9 percent of water content in the seed contents exclusive of the seed coats. The crops were collected at the end of nearly two months without rain at these sites in Corcovado, and all seeds collected were fully mature and as dry as they would ever have been. Variation in weight was not due to variation in the degree of maturity or desiccation of the seeds.

Archival

In keeping with the realization that except for a very few National Parks and other preserves, data such as recorded here will be unavailable in the future, I report all

the raw data in Table 2. In further justification of the mind-numbing use of two pages for such base data, I note that the seeds of *Mucuna mutisiana* are extremely painful to collect owing to the urticating hairs on the fruits, and they are labor-intensive to process and weigh. To report only summary statistics for this information would represent a significant waste of future investigators' time.

Results

The majority of *M. mutisiana* fruits were 2-seeded on all seven plants; additionally, when pooled across all plants, 7, 88 and 5 percent of the 911 seeds were in 1-, 2- and 3-seeded fruits (Table 1). Two of the plants had no 3-seeded fruits. In casual inspection of hundreds of *M. mutisiana* fruits in Corcovado National Park, I have never found one with more than three seeds in it. This maximum number of seeds is not a generic trait; I have seen *Mucuna andreana* fruits with as many as six seeds and *Mucuna urens* fruits with as many as five seeds in Costa Rica.

Considering just the seeds from the 2-seeded fruits, it is evident that each liana does not produce seeds of the same average weight. Plants 1, 3, 4, and 5 have significantly different mean seed weights; the most similar, 1 and 4, are still significantly different ($t = 3.2039$, 224 d.f., $p < .05$). The heaviest seeds, with an average of 9.08 g (plant 3), are significantly heavier than are the average weights for each of the other plants. Plants 2, 5, 6, 7, however, did not have significantly different average seed weights (Table 1).

In 11 of the 12 possible cases for comparison, the seeds from 1- and 3- seeded fruits appear to be lighter than are those from 2-seeded fruits (plant 4 has equal values). However, in the six contrasts where there are ten or more seeds in each subsample, three are significantly different (t tests: 1- vs 2-seeded, plant 3; 2- vs 3-seeded, plant 6; 2- vs 3-seeded, plant 2) and three are not. In short, the mean seed weights in Table 1 suggest that very large sample sizes may show that seeds in 2-seeded fruits are significantly heavier than are those in 1- and 3-seeded fruits, but for the present the best that can be concluded is that for any given plant, only sometimes will seeds in 2-seeded fruits be heavier (and never lighter).

While the average seed weights ranged from about 7 to 9 grams in 2-seeded fruits, the weight ranges within the crops were greater and instructive (Table 1). In five of the seven plants, the lightest seeds in the entire crop are in the 2-seeded fruits and in all cases the heaviest seeds are also in the 2-seeded fruits. A scan of the actual numbers shows clearly that not only is the heaviest seed in a crop to be found in a 2-seeded fruit, but many 2-seeded fruits have seeds that are heavier than average. It is also clear that the heaviest seeds are not to be found in the 1-seeded fruits, nor are the lightest to be found in the 3-seeded fruits.

Discussion

The weight of a *Mucuna mutisiana* seed is determined by the amount of material moved into it by the maternal parent (*M. mutisiana* has achlorophyllous developing embryos, and therefore cannot accumulate its own resources from the non-maternal environment; c.f. Janzen 1982b). If each seed was a quite independent unit (sink), then there should be no difference in seed weight among fruits of different seedinesses. However, in *M. mutisiana* there are several indications that seed in 2-seeded fruits have a slight edge over other seeds in obtaining nutrients from the parent plant. It may well be that when there are three seeds in a *M. mutisiana* fruit, the capacity of the plant to maximally fill all of them may be exceeded, given that the resource provision program for a fruit may be set up for the much more common case of a 2-seeded fruit. On the other hand, when there is only one seed in a fruit, it may be that the fruit and seed collectively are issuing a fainter hormone message per seed than is delivered by a 2-seeded fruit and its seeds. However, nothing is known of to what degree the seed itself is calling in nutrients, and to what degree the fruit is the unit to which the plant is responding.

In *M. mutisiana* the fruit is not the dispersal unit and the number of seeds per fruit is not being selected for through interactions with a dispersal process; the number of seeds per fruit must therefore be the consequence of phylogenetic inertia, avoidance of seed predators, mate choice (selective abortion), and matching with physiological capabilities. We know virtually nothing of these things except that at least sometime during the history of this plant there was (and may still be) a selection for intensely urticating hairs on the maturing fruit (when the seeds are still soft, they are - on occasion in Corcovado - eaten by parrots that cut open the fruit). Likewise, it is probable that the ovary normally bears three ovules, one of which is aborted to yield the usual 2-seeded fruit. However, it is also possible that it is commonplace to abort until the fruit is 1-seeded, and then to discard most of these fruits because they are 1-seeded fruits.

Since the fruit is not the dispersal unit, it is tempting to wonder why the plant does not make just few very long fruits, each with many seeds (as is the case in plants such as *Cassia grandis*, Janzen 1977b). First, such long fruits increase the damage effects from a predator that has eaten only a few immature seeds (the usual pattern with *Mucuna* spp. is that the small amounts of parrot (or squirrel) damage are in the form of 1-2 seeds being bitten out of a fruit - the remainder of the seeds are then killed by fruit malfunction or pathogen entry through the wound). Second, a large number of few-seeded fruits gives substantially more options for selective abortion well into seed life (after the fruit is partly formed) than do a few many-seeded fruits. Third, if suitable pollen grains are arriving only in small amounts at irregular intervals, the economics of reproductive physiology may be more favorable in a system that makes a continuous flow of few-ovuled flowers rather than a smaller number of many-ovuled flowers, a few of which would have to receive a very large amount of pollen to produce a high quality many-seeded fruit.

Whatever interpretations are given to the data in Table 1, *M. mutisiana* is one of the largest-seeded plants in the Corcovado rainforest. It also makes only a small crop of seeds (the canopy of a *M. mutisiana* vine with a 200-seed crop may have as much foliage volume as has a medium-sized rainforest tree). These seeds are nearly free from seed-predation during development and there are no known seed predators on the mature seeds (the report in Bell and Janzen 1971, that a neotropical species of *Mucuna* has an insect seed predator, was an error based on the misidentification of *Dioclea* (Leguminosae) as *Mucuna*). *Mucuna* seeds are rich in the potentially toxic uncommon amino acid L-dopa (Bell and Janzen 1979, Rehr *et al* 1973; cf. Janzen *et al* 1977 for L-dopa toxicity) and probably contain other toxins (Janzen *et al* 1986). This is expected on the basis of their large size and freedom from seed predator attack (Janzen 1969). In short, the fruit and seed crop traits reported here are those of a plant that has minimal animal-seed interactions in ecological time, though it is still impossible to know to what degree present ovule, seed and fruit traits were shaped by long-gone interactions with animals.

Resumen

Mucuna mutisiana (Leguminosae) es un bejuco grande y leñoso común en el bosque secundario del Parque Nacional Corcovado, en el suroeste de Costa Rica. El bejuco tiene frutos grandes que normalmente contienen solamente dos semillas, pero a veces pueden contener tres semillas. El peso promedio de las semillas en los frutos con dos semillas fue 9.08-6.86 g, y estas semillas siempre pesaron igual o más que las semillas de frutos con una o tres semillas en la misma planta. Cada una de las cuatro de las ocho cosechas tuvieron semillas significativamente diferentes en peso que las semillas en las otras siete cosechas. Las semillas más livianas y las semillas más pesadas en una cosecha estuvieron casi todo el tiempo en frutos con solamente dos semillas. Dado que las semillas de *M. mutisiana* casi no son atacadas por depredadores y las semillas no se dispersan por medio de animales, estos parámetros para la cosecha han sido evolutivamente producidos por otras fuerzas.

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Table 1. Seed weight parameters for 1-, 2- and 3-seeded fruits of *Mucuna mutisiana*.

Plant number	\bar{X} (g)			S.D.			n			weight range (g)		
	Number of seeds per fruit			Number of seeds per fruit			Number of seeds per fruit			Number of seeds per fruit		
	1	2	3	1	2	3	1	2	3	1	2	3
3	8.39	9.08	N/A	1.00	0.63	N/A	20	42	none	6.36-9.79	7.60-10.18	none
4	8.06	7.80	7.30	0.99	0.87	0.80	14	138	3	6.42-9.38	5.97-10.15	6.54-8.13
1	6.80	7.47	7.08	1.32	0.66	0.83	5	86	6	5.51-8.68	5.69-8.90	5.85-8.07
5	6.38	7.03	N/A	0.20	0.73	N/A	3	36	none	6.17-6.57	5.09-8.24	none
7	6.56	6.97	6.92	0.90	0.83	0.65	10	82	6	5.17-7.70	3.37-8.28	6.29-7.81
6	6.90	6.94	6.61	1.22	0.69	0.48	3	116	15	5.81-8.22	4.10-8.52	5.91-7.39
2	6.54	6.86	5.43	0.54	0.89	1.02	11	300	15	5.59-7.37	4.68-8.82	4.19-7.36
Σ								66(7 ^o b)	800(88 ^o b)	45(5 ^o b)		

Table 2. Actual weights of mature *Mucuna mutisiana* seeds. See text for details. All weights in grams.

Plant #1. 1-seeded fruits, 5.15, 6.06, 6.87, 7.23, 8.68; 2-seeded fruits, 5.69, 6.16, 6.24, 6.29, 6.32, 6.41, 6.49, 6.52, 6.54, 6.55, 6.56, 6.75, 6.83, 6.84, 6.85, 6.90, 6.91, 6.92, 6.93, 6.96, 7.00, 7.07, 7.07, 7.08, 7.08, 7.11, 7.13, 7.15, 7.15, 7.23, 7.28, 7.30, 7.30, 7.33, 7.34, 7.39, 7.41, 7.43, 7.46, 7.47, 7.48, 7.48, 7.49, 7.49, 7.54, 7.57, 7.58, 7.63, 7.63, 7.66, 7.66, 7.69, 7.70, 7.72, 7.78, 7.83, 7.84, 7.85, 7.86, 7.87, 7.87, 7.90, 7.91, 7.93, 7.96, 7.96, 7.98, 8.04, 8.04, 8.13, 8.15, 8.17, 8.18, 8.18, 8.23, 8.23, 8.32, 8.34, 8.36, 8.46, 8.49, 8.51, 8.68, 8.71, 8.90; 3-seeded fruits, 5.85, 6.45, 7.01, 7.31, 7.77, 8.07

Plant #2. 1-seeded fruits, 5.59, 5.80, 6.29, 6.43, 6.52, 6.52, 6.64, 6.65, 6.85, 7.30, 7.37; 2-seeded fruits, 4.03, 4.68, 4.81, 4.85, 4.87, 4.92, 4.94, 4.97, 4.99, 5.01, 5.07, 5.08, 5.12, 5.18, 5.26, 5.29, 5.30, 5.30, 5.32, 5.41, 5.43, 5.50, 5.51, 5.52, 5.53, 5.58, 5.60, 5.60, 5.60, 5.62, 5.62, 5.68, 5.74, 5.74, 5.78, 5.78, 5.79, 5.81, 5.83, 5.83, 5.83, 5.84, 5.90, 5.90, 5.93, 5.94, 5.94, 5.95, 5.96, 5.98, 5.98, 5.99, 6.00, 6.00, 6.00, 6.01, 6.03, 6.03, 6.04, 6.04, 6.08, 6.12, 6.13, 6.16, 6.17, 6.18, 6.18, 6.18, 6.18, 6.20, 6.20, 6.21, 6.22, 6.22, 6.25, 6.25, 6.27, 6.28, 6.28, 6.30, 6.30, 6.31, 6.31, 6.33, 6.34, 6.35, 6.37, 6.37, 6.38, 6.38, 6.38, 6.38, 6.40, 6.40, 6.43, 6.43, 6.44, 6.44, 6.44, 6.44, 6.45, 6.47, 6.47, 6.49, 6.49, 6.49, 6.50, 6.50, 6.54, 6.56, 6.57, 6.57, 6.59, 6.60, 6.61, 6.64, 6.66, 6.66, 6.66, 6.67, 6.67, 6.69, 6.69, 6.71, 6.72, 6.72, 6.73, 6.74, 6.75, 6.76, 6.78, 6.78, 6.79, 6.80, 6.81, 6.82, 6.82, 6.83, 6.85, 6.85, 6.87, 6.87, 6.87, 6.88, 6.88, 6.90, 6.91, 6.93, 6.94, 6.95, 6.97, 6.98, 6.98, 6.99, 7.04, 7.05, 7.06, 7.08, 7.09, 7.10, 7.10, 7.11, 7.11, 7.12, 7.12, 7.13, 7.13, 7.13, 7.13, 7.13, 7.13, 7.14, 7.15, 7.15, 7.15, 7.16, 7.16, 7.17, 7.18, 7.19, 7.20, 7.22, 7.22, 7.23, 7.23, 7.24, 7.26, 7.26, 7.27, 7.27, 7.27, 7.30, 7.31, 7.32, 7.32, 7.32, 7.33, 7.34, 7.35, 7.36, 7.37, 7.37, 7.38, 7.39, 7.40, 7.42, 7.42, 7.42, 7.43, 7.44, 7.45, 7.45, 7.45, 7.46, 7.48, 7.50, 7.50, 7.51, 7.51, 7.53, 7.53, 7.54, 7.54, 7.54, 7.56, 7.56, 7.58, 7.58, 7.59, 7.59, 7.62, 7.66, 7.66, 7.66, 7.68, 7.68, 7.69, 7.69, 7.69, 7.70, 7.71, 7.72, 7.73, 7.74, 7.75, 7.76, 7.76, 7.77, 7.78, 7.78, 7.79, 7.79, 7.81, 7.82, 7.83, 7.84, 7.88, 7.88, 7.89, 7.89, 7.89, 7.89, 7.92, 7.93, 7.93, 7.95, 7.95, 7.96, 7.96, 7.98, 7.99, 7.99, 8.01, 8.01, 8.02, 8.03, 8.04, 8.04, 8.05, 8.07, 8.07, 8.10, 8.10, 8.12, 8.12, 8.13, 8.14, 8.16, 8.17, 8.18, 8.26, 8.32, 8.33, 8.34, 8.43, 8.51, 8.65, 8.82; 3-seeded fruits, 4.19, 4.26, 4.27, 4.35, 4.86, 5.16, 5.41, 5.44, 5.49, 5.64, 6.02, 6.13, 6.37, 6.50, 7.36

Plant #3. 1-seeded fruits, 6.36, 6.47, 6.59, 7.54, 7.94, 8.01, 8.22, 8.27, 8.54, 8.62, 8.68, 8.71, 8.78, 8.85, 8.94, 8.97, 9.30, 9.54, 9.67, 9.79; 2-seeded fruits, 7.60, 7.97, 8.05, 8.06, 8.24, 8.42, 8.54, 8.54, 8.65, 8.69, 8.73, 8.75, 8.81, 8.84, 8.85, 8.98, 8.98, 9.02, 9.03, 9.13, 9.16, 9.19, 9.23, 9.26, 9.27, 9.32, 9.34, 9.38, 9.42, 9.42, 9.58, 9.70, 9.75, 9.81, 9.81, 9.84, 9.84, 9.86, 9.98, 10.09, 10.18; 3-seeded fruits, none.

Plant #4. 1-seeded fruits, 6.42, 6.73, 6.97, 7.24, 7.33, 7.72, 8.05, 8.23, 8.83, 8.84, 8.97, 9.03, 9.03, 9.38; 2-seeded fruits, 5.79, 5.81, 5.97, 5.98, 6.12, 6.18, 6.30, 6.48, 6.49, 6.60, 6.66, 6.66, 6.69, 6.76, 6.80, 6.81, 6.81, 6.82, 6.83, 6.84, 6.86, 6.89, 6.92, 6.93, 6.98, 6.99, 6.99, 7.06, 7.07, 7.11, 7.17, 7.18, 7.21, 7.22, 7.23, 7.27, 7.31, 7.34, 7.34, 7.38, 7.38, 7.39, 7.40, 7.40, 7.42, 7.43, 7.44, 7.47, 7.47, 7.48, 7.51, 7.52, 7.55, 7.57, 7.58, 7.58, 7.59, 7.60, 7.62, 7.62, 7.63, 7.64, 7.66, 7.67, 7.67, 7.69, 7.70, 7.70, 7.73, 7.74, 7.74, 7.76, 7.79, 7.80, 7.80, 7.81, 7.81, 7.83, 7.83, 7.85, 7.88, 7.88, 7.94, 7.98, 7.98, 8.00, 8.04, 8.05, 8.08, 8.11, 8.14, 8.14, 8.15, 8.21, 8.24, 8.25, 8.25, 8.26, 8.26, 8.26, 8.29, 8.30, 8.32, 8.33, 8.36, 8.40, 8.41, 8.42, 8.44, 8.49, 8.49, 8.49, 8.52, 8.57, 8.58, 8.65, 8.65, 8.66, 8.73, 8.80, 8.83, 8.85, 8.89, 9.02, 9.02, 9.03, 9.06, 9.10, 9.15, 9.30, 9.35, 9.42, 9.46, 9.52, 9.54, 9.56, 9.92, 10.15; 3-seeded fruits, 6.54, 7.22, 8.13

Plant #5. 1-seeded fruits, 6.17, 6.44, 6.57; 2-seeded fruits, 5.09, 5.14, 5.61, 6.06, 6.26, 6.41, 6.55, 6.59, 6.60, 6.61, 6.65, 6.69, 6.88, 6.94, 6.95, 7.15, 7.27, 7.29, 7.31, 7.32, 7.36, 7.36, 7.37, 7.40, 7.41, 7.41, 7.44, 7.50, 7.52, 7.57, 7.62, 7.67, 7.86, 7.94, 8.17, 8.24; 3-seeded fruits, none.

Plant #6. 1-seeded fruits, 5.81, 6.67, 8.22; 2-seeded fruits, 4.10, 5.33, 5.51, 5.72, 5.74, 5.76, 5.81, 5.89, 5.92, 6.06, 6.09, 6.10, 6.13, 6.18, 6.23, 6.23, 6.24, 6.26, 6.31, 6.32, 6.35, 6.41, 6.42, 6.43, 6.43, 6.45, 6.46, 6.46, 6.47, 6.51, 6.51, 6.51, 6.51, 6.52, 6.54, 6.58, 6.59, 6.62, 6.62, 6.63, 6.63, 6.65, 6.66, 6.69, 6.70, 6.72, 6.74, 6.76, 6.79, 6.90, 6.90, 6.91, 6.94, 6.94, 6.96, 6.99, 7.00, 7.00, 7.01, 7.03, 7.03, 7.05, 7.06, 7.08, 7.11, 7.12, 7.12, 7.13, 7.15, 7.15, 7.17, 7.23, 7.23, 7.24, 7.26, 7.26, 7.27, 7.29, 7.31, 7.34, 7.36, 7.36, 7.37, 7.37, 7.39, 7.40, 7.40, 7.40, 7.41, 7.41, 7.43, 7.46, 7.46, 7.47, 7.50, 7.51, 7.57, 7.59, 7.61, 7.65, 7.66, 7.79, 7.80, 7.82, 7.82, 7.84, 7.87, 7.90, 7.90, 7.90, 8.08, 8.10, 8.24, 8.44, 8.52; 3-seeded fruits, 5.19, 5.92, 6.07, 6.22, 6.34, 6.36, 6.54, 6.54, 6.56, 6.88, 6.97, 7.03, 7.19, 7.20, 7.39

Plant #7. 1-seeded fruits, 5.17, 5.28, 5.76, 6.41, 6.59, 6.69, 7.28, 7.28, 7.39, 7.70; 2-seeded fruits, 3.37, 4.85, 4.98, 5.38, 5.67, 5.78, 5.78, 5.88, 5.91, 5.94, 5.96, 6.15, 6.18, 6.21, 6.35, 6.39, 6.42, 6.46, 6.47, 6.47, 6.52, 6.53, 6.66, 6.70, 6.71, 6.74, 6.74, 6.80, 6.84, 6.84, 6.85, 6.91, 6.93, 6.95, 6.96, 6.98, 6.99, 7.04, 7.05, 7.07, 7.08, 7.09, 7.15, 7.16, 7.17, 7.20, 7.22, 7.26, 7.27, 7.27, 7.35, 7.35, 7.35, 7.37, 7.37, 7.41, 7.42, 7.44, 7.46, 7.49, 7.50, 7.50, 7.52, 7.56, 7.66, 7.68, 7.69, 7.71, 7.75, 7.75, 7.75, 7.77, 7.79, 7.85, 7.86, 7.87, 7.92, 8.00, 8.10, 8.14, 8.21, 8.28; 3-seeded fruits, 6.29, 6.30, 6.55, 7.03, 7.55, 7.81