Regional Differences in the Quality of Castor Seeds and Oil

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Introduction

Castor seed as is widely known, is one of the most important agricultural products used as material for producing industrial oil and approximately 40,000 tons of castor seeds are annually imported to Japan from tropical regions.

It is recognized that considerable variation in the characteristics of seeds is found as well as difference in the quality of the oil, according to the respective countries.

The major causes of the difference in castor seed quality can be classified into three factors: meteorological condition, ecological and physiological differences of growing plants, and environmental condition of the storage and shipping period.

The author has attempted to find the causes which influence the characteristics of the seeds and oil quality, from the viewpoint of meteorological and regional differences and herein introduces in outline the result obtained from his research.

Castor plants in tropical regions

Castor plants grown in the tropical regions are perennial so that they continue flowering

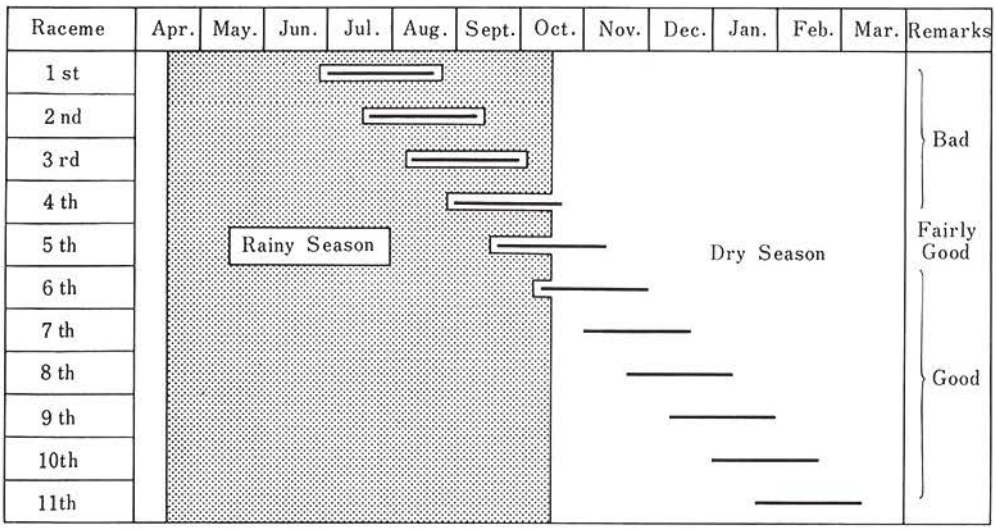

Fig. 1. The period from flowering to maturity of castor seeds in relation to rainy and dry seasons in Thailand.

and ripening throughout the year, but in most of the tropical regions where castor plants thrive, a sharp line can be drawn between rainy and dry seasons. Weather conditions during the rainy season largely affect both seed development and the quality of oil.

According to this author's investigations at the Banmaisamrong Experiment Station in Thailand in 1960, the relationship between plant growth, especially in the development of seeds, and the dry season is shown in Fig. 1.

In Thailand, rainy season begins in the middle of April and castor seeds are sown towards the end of April. In early July, (though a slight difference is found among varieties of castor seeds) 1st raceme begins to flower and flowering continues gradually towards upper racemes of the plants. As the rainy season continues to the middle of October, the ripening seeds from racemes which bloomed during the rainy season (1st to 5th) deteriorate more in quality than those which bloomed in the dry season. The causes for seed deterioration are summarized as follows:

1. Insufficient fertilization by heavy rain.
2. Increase of moisture content of the seeds caused by higher relative humidity.
3. Decrease of oil content by higher relative humidity.
4. Increase of acid value of oil by higher relative humidity.
5. Increase of crude protein content by higher relative humidity and lack of sunshine.

From the 6th raceme on, damage by heavy rainfall can be decreased and superior seeds can be produced. These racemes mature in the period from the middle of October to the following April. This also shows that trade rumor about the difference in quality between the 1st and 2nd crops is not entirely unfounded (though the 1st and the 2nd crops are not recognized as technical terms).

In cultivating castor seeds in the tropical regions, there is no problem of air temperature throughout the year, but higher relative humidity and the lack of sunshine have a great influence on the seed characteristics as well as on the quality of oil.

High temperature accompanied by higher relative humidity not only promotes vegetative growth but also accelerates esterase activities in the seeds, so that free fatty acid is increased, raising the acid value of oil and thus delaying oil formation. On the other hand, environmental handicaps for oil formation promote protein synthesis. Therefore, for oil formation, high temperature with high relative humidity should be avoided.

Castor plants in temperate zone

In Tokyo, castor seeds sown in the middle of May flower their 1st racemes at the beginning of June and flowering continues until November when autumn chill comes. As castor is not a perennial plant in the temperate zone, the growth of the plant is limited. In Tokyo, generally the 1st to the 5th racemes can reach

Table 1. Quality of castor seeds in relation to the maturing period (Shanghai variety)

Harvested time (fully-matured)		Moisture content		Oil content		Crude protein content		Acid value of oil	
		Upper half	Lower half	Upper half	Lower half	Upper half	Lower half	Upper half	Lower half
		%	%	%	%	%	%	%	%
Aug.	end	5.67	5.73	51.46	50.86	31.67	31.02	0.74	0.84
Sept.	first	5.17	5.17	51.14	52.46	28.86	29.48	0.38	0.39
	middle	5.07	5.18	50.55	51.42	28.41	27.63	0.67	0.59
	end	5.24	5.32	51.35	51.62	27.88	28.15	0.50	0.48
Oct.	first	5.13	5.29	51.16	51.28	27.86	28.56	0.40	0.54
	middle	5.20	5.19	51.73	52.16	29.56	28.69	0.71	0.71
	end	4.76	4.72	52.09	51.84	29.78	29.26	1.05	1.09
Nov.	first	4.78	4.86	51.55	51.48	28.82	29.93	1.03	0.97
LSD (P=0.05)		0.12	0.16	N.S.	N.S.	0.67	0.70	0.31	0.29

their maturity though their quality differs. The difference in the seed quality is as shown in Table 1.

The Shanghai variety used at the author's university took 40 days from flowering to maturity, and according to Table 1, the seeds harvested at the end of August are the ones that bloomed in the rainy season in Japan. These seeds show a higher moisture content and higher acid value of oil.

On the contrary, the seeds which matured in September, having bloomed after the rainy season show a higher quality. In the middle of October, a sharp ascension is found in both acid value of oil and crude protein content within the matured seeds. It is recognized that this tendency is due to the decrease of lipase activity caused by the lower temperature in autumn and the fatty acid transformed from carbohydrate is not completely synthesized yet and is probably being suspended in the form of free fatty acid within the seeds.

From these facts mentioned above, high relative humidity and lack of sunshine are considered to be the common factors causing deterioration of seed characteristics and oil quality in both tropical and temperate zones. In the temperate zone, the lower temperature is another factor which prevents oil formation in the seeds.

Castor plants in arid zone

High temperature with high relative humidity and the lack of sunshine being considered as deteriorating factors for the castor seed characteristics as well as for oil quality, it was now required to cultivate the castor plants in a special environment where none of those deteriorating factors existed. Such a special environmental satisfying the above conditions and also with the highest temperature and the lowest relative humidity, as well as ample sunshine during the growing season, can be found nowhere but in the desert.

Table. 2. Comparison of castor seeds harvested in Kuwait and in Tokyo

Variety	Seed *** source	Moisture * content	Oil ** content	Crude protein ** content	Iodine value	Acid value
		%	%	%		
Kuwaiti	K/K	3.80	66.31	25.92	85.59	0.23
	K/J	4.69	60.92	30.35	84.67	0.78
Shanghai	J/K	4.26	64.89	27.44	85.63	0.27
	J/J	5.13	64.55	28.90	85.11	0.32
	J/K/J	4.70	65.03	28.38	85.38	0.35
LSD (P=0.05)		0.07	1.17	0.50	0.16	0.09

* Calculated per fresh weight of endosperm.

** Calculated by dry basis.

*** Shows the place where the source plants were grown ; for instance, K/J shows the plants grown in Japan from the seeds produced in Kuwait the previous year.

Table 3. Characteristics of castor seeds harvested in Kuwait and in Tokyo

Variety	Seed source	Seed size			100-seed weight		Endosperm percent
		Length	Width	Thickness	Seed	Endosperm	
		cm	cm	cm	g	g	%
Kuwaiti	K / K	1.27	0.88	0.60	33.6	26.8	79.96
	K / J	1.10	0.82	0.54	20.0	13.3	66.50
Shanghai	J / K	1.45	0.89	0.69	43.8	34.0	77.74
	J / J	1.17	0.78	0.57	27.0	20.7	76.53
	J/K/J	1.20	0.78	0.56	27.8	21.4	76.95

In the desert at Kuwait, the author found native castor plants and obtained their seeds, and at the same time cultivated the Shanghai variety, whose seeds had been obtained at the author's University Farm in his attempt to compare characteristics of both seeds and quality of oil, and also to research the adaptability of castor plants in the Kuwaiti desert. The results from this experiment are shown in Table 2. Also, Kuwaiti seeds were planted at the University Farm in Tokyo.

According to Table 2, the Kuwait variety (K/K) showed the highest oil content and the lowest moisture, crude protein content and acid value of oil. The Shanghai seeds harvested in Kuwait (J/K) showed far more excellent quality seed characteristics and in chemical composition than those harvested in Japan.

On the contrary, Kuwaiti seeds harvested in Tokyo (K/J) showed the lowest oil content and the highest crude protein content and acid value of oil, so that they had deteriorated extremely in every aspect. Furthermore, the Shanghai seeds harvested in Kuwait turned out to be the largest both in size and weight (Table 3).

The production of superior seeds in Kuwait is attributed to the special climate of that country. In Kuwait, a ten years' record of the average air temperature from 1955 to 1964 shows 37° C in July and the relative humidity averaged 29%. There is no rainfall from June to October and even clouds are scarcely seen so that light intensity is quite sufficient for the assimilation of castor plants and more than 200,000 Lux of light intensity was determined at culmination time in summer, according to the author's observations in Kuwait in 1969.

From the above results, high temperature with low relative humidity accompanied by ample solar energy are indispensable for seed development and oil formation. It is also suggested by the author's experiment that the formation of the ricinoleic acid, a major fatty acid of castor oil, may be promoted by strong sunshine.

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