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Revolution of Cocoa Beans in Malaysia: Bulk to Specialty Beans

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The Malaysian cocoa industry needs a sustainable and consistent supply of cocoa beans with the quality attributes of specialty cocoa beans to meet the diverse and increasing requirements of the world prospect. It is aimed to transform and implement a specialty cocoa value chain in Malaysia, to help small-scale cocoa growers gain access to high value markets. The efforts towards developing Malaysia as fine flavour cocoa producing country involve a range of activities at all levels of the cocoa value chain. Promising varieties recognised through the Cocoa Excellence programme with unique characteristics have been identified and adapting high-yield growing techniques to increase productivity is the next challenge in order to get sufficient volume, with proper post-harvest processing and rigorous quality control and traceability. As the world demand for fine flavour cocoa has been growing, initiatives should be taken on several key research components, including identifying clones with specialty beans and suitable regions for growing cocoa, determine flavour evaluation not only sensory but DNA fingerprinting of selected materials, selecting potential specialty cocoa varieties among genetic collection and train growers especially smallholders, to follow the recommended practices. Also, a more in-depth market study will be necessary to give and guide the industry with more detailed recommendations on fine or flavour cocoa investments such as price, quality and volumes. Certification is another requirement by specialty cocoa buyers and retailers as an important proof of commitment to sustainability. The demand for certification of cocoa and chocolate is growing strongly in the European and global cocoa market.

Keywords*: Specialty beans, fine flavour cocoa, cocoa varieties, bean quality, post-harvest technique, sustainable cocoa industry.*

The cocoa tree (*Theobroma cacao* L.) is native to the tropical rainforest and is a major source of income for farmers in Africa, Central and South America and Asia. Beans from the *T. cacao* is characterised by potential genetic diversity in producing fine or flavour cocoa with the presence of special aroma notes such as fruity, spicy, nutty and floral, which are normally absent in bulk cocoa. Notably, cocoa beans are the key raw material contributing to the multi-billion-dollar chocolate industry today with high demand in fine cocoa.

JOURNEY FROM HISTORICAL ORIGIN OF COCOA TO SPECIALTY BEANS IN MALAYSIA

The planting of cocoa had been increasing extensively in the tropics since the nineteenth century. In Malaysia, commercial cultivation

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of cocoa had become the third major commodity crop in the country after oil palm and rubber.

Malaysia is a tropical country blessed with good soil and climatic conditions suitable for cocoa cultivation with sufficient annual rainfall between 1 500 - 2 500 mm, with an average temperature range of 18^0C-33^0C and no persistent strong wind. Dry season (<100 mm rainfall/month) normally does not exceed three consecutive months and this means only in some parts of the country. These climatic conditions are favourable for vigorous growth of cocoa and fruiting generally start about 24-30 months after field planting.

Cocoa crop was introduced into Malaya in 1934, in a small plot at the Agricultural Research Station, Serdang in Peninsular Malaysia (Faulkner & Milsum, 1938). In 1937, the seeds from selected high yielding trees were used for the establishment of a number of experimental plots at Kuala Lipis and Temerloh (Pahang) and Serdang (Selangor). In the late 1940s, cocoa trees in Serdang and Temerloh became the main source of seeds for planting in Peninsular Malaysia.

The first commercial planting of cocoa was established at Jerangau (Terengganu) in 1950, with Trinitario varieties (Haya *et al.*, 2006). Subsequently in the 1950s, Amelonado cocoa and its hybrids were also planted, but were found to be unsuitable to the local environment due to susceptibility to vascular streak dieback (VSD) disease, poor tolerance to no shade condition (high light intensity) and low yielding compared to varieties such as AML x PA 7, AML x SCA 9 (Series I) and others (Haya *et al.*, 2019). Between 1951 and 1962, Amelonado cocoa was further established in Tawau. Trinitario varieties were then planted in Tenom. More plantings were established at BAL Plantations and Quoin Hill, Tawau in 1958 (DOA North Borneo, 1957, 1958, 1959).

In the 1970s to 1980s, the Department of Agriculture (DOA) of Quoin Hill, Tawau (Sabah) had developed high yielding (Series II) Trinitario and Forastero hybrids of Upper Amazon origin also known as 'Sabah mixed hybrids' (*Table 1*), through variety improvement and agronomic practices programmes. These varieties had a high degree of tolerance against diseases (Series III) and were more vigorous compared to Amelonado (Series I) hybrids (Phua, 1982; Chong & Lee, 1982).

From the programmes implemented as mentioned earlier, several other cocoa hybrids had been released for planting by the DOA, Sabah. The recommended hybrids are shown in *Table 2*.

The use of hybrid cocoa planting materials in Malaysia was later shifted to clonal materials due to higher yields and better tolerance to pests and diseases. Clonal materials apart from better pod formation have improved bean quality *via* higher cocoa butter content, good flavour and more uniform characteristics compared to hybrid materials. The development of first cocoa clonal trial was conducted by the DOA (Malaya) in 1956 at Jerangau, with planting materials obtained from progeny trial plots and the collection of imported clones (Arasu & Phang, 1972). In the early 1970s, the expansion of the cocoa clonal materials was promising and able to fulfil the requirement of the planting materials.

Between 1971 to 2000, more than 100 clones had been recommended for commercial planting from various agencies that developed the planting materials (Haya *et al.*, 2006). The Malaysian Agricultural Research and Development Institute (MARDI) had recommended 15 clones gradually in 1983, 1986 and 1989. These clones were KKM1, KKM2, KKM3, KKM4, KKM5, KKM6, KKM7,

TABLE 1
SUMMARY OF SABAH MIXED HYBRIDS OF COCOA RELEASED FOR PLANTING

Sabah mixed hybrids	*Period cocoa released*	*Annual dry bean yield (kg/ha)*						
		1984	*1985*	*1986*	*1987*	*1988*	*1989*	*Mean*
AML x PA 7		2056	3539	2643	3268	3007	3513	3004.3
PA 7 x NA 32	Series 1	2659	3588	2532	2993	3025	3507	3050.7
UIT 2 x PA 7	1960s	2603	4046	2434	3106	2939	3031	3026.5
UIT 1 x NA 33		2493	2904	1896	2463	2486	2555	2466.2
UIT 1 x NA 32		2091	2750	1739	2454	2112	1975	2186.8
Mean		2380.4	3365.4	2248.8	2856.8	2713.8	2916.2	2746.9
UIT 2 x SCA 6		1794	2841	2890	3862	3126	4519	3172.0
UIT 1 x SCA 6	Series II	1799	2547	2060	4004	3633	3648	2948.5
UIT 2 x SCA 12	1970s	2019	2532	2416	3935	3488	3734	3020.7
UIT 1 x SCA 12		1579	2406	2449	3722	3451	3752	2893.2
Mean		1797.8	2581.5	2453.8	3880.8	3424.5	3913.3	3008.6
PA 156 x SCA 9		753	1159	1622	2808	3007	3817	2194.3
PA 156 x IMC 67	Series III	1079	1620	1859	2823	2934	3662	2329.5
PA 138 x SCA 9	1980s	857	1278	1433	2422	3063	3742	2132.5
PA 173 x SCA 9		667	1063	1471	2575	2850	3449	2012.5
IMC 67 x SCA 9		975	1300	1400	2416	2466	2816	1895.5
Mean		866.2	1284.0	1557.0	2608.8	2864.0	3497.2	2112.9

TABLE 2
RECOMMENDED SABAH MIXED HYBRIDS OF COCOA RELEASED FOR PLANTING

Hybrid	*Dry bean yield (kg/ha/year)*	*Pod value**	*Average bean weight (g)*	*Bean number per pod*
UIT 1 x NA 33	2254	21.4	1.20	39
UIT 1 x SCA 6	2494	26.6	1.01	39
UIT 1 x SCA 12	2328	25.8	1.11	37
IMC 67 x SCA 9	1416	24.2	1.00	43
PA 156 x IMC 67	1704	23.1	1.12	41
PA 156 x SCA 9	1707	26.3	0.99	42
PA 138 x SCA 9	1688	25.8	1.01	40
PA 173 x SCA 9	1521	27.9	1.01	36

*Pod value refers to number of cocoa pods required to produce 1 kg of dry beans

KKM15, KKM17, KKM19, KKM22, KKM25, KKM26, KKM27 and KKM28. Meanwhile, the DOA (Sabah), had released ten clones in two phases which were in 1994 and 1997. The clones are QH22, QH37, QH186, QH240, QH441, QH326, QH968, QH1003, QH1176 and QH1287.The Borneo Abaca Limited (BAL), had recommended

several clones for planting such as BAL204, BAL208, BAL209 and BAL216 (Ang & Lim, 1987). Golden Hope Plantation had developed and released some cocoa clones which were initiated in 1982. The clones were PBC113, PBC130, PBC137, PBC139, PBC162, PBC178, PBC207, PBC123, PBC140, PBC159, PBC170, PBC179, PBC208 and PBC211 (Haya *et al.*, 2006). The Malaysian Cocoa Board (MCB) also released 14 clones for commercial planting in 2005, 2009 and 2013; namely MCBC 1 to MCBC 14 (*Table 3*). These were quite similar to one of the famous early clonal planting material, PBC 123 (*Figure 1*). Information on the current Malaysian cocoa clones is shown in *Table 4*.

From the year 2000 onwards, cocoa clones selected were with better tolerance to major pest and diseases, had larger bean size, bean weight and higher butter content (*Table 5*). More recent selections showed better productivity and bean production which indicated that over time improvement in yield is attained with improved varieties.

Apart from that, MCB had recommended 53 commercial clones (*Table 6* & *Figure 1*) for planting throughout Malaysia. These including the 14 MCB clones (Aizat *et al.*, 2020) were categorised into four classes. The classes were used based on location suitability and clones' characteristics including pod and beans characteristics and pest and disease tolerance.

CURRENT SCENARIO OF MALAYSIAN BEANS

High favourable prices of cocoa in the 1980s triggered rapid expansion of the cocoa planting in Malaysia with 123 855 ha producing 36 500 tonnes of dried cocoa beans in 1989. Subsequently, further expansion of cocoa

TABLE 3
CHARACTERISTICS OF MCB COCOA CLONES

Clone	*Potential dry bean yield (kg/tree/yr)*	*Pod value*	*Average dry bean weight (g)*	*Bean number per pod*	*Cocoa butter content (%)*	*Cocoa powder content (%)*
MCBC 1	3.59	19.2	1.30	39	56	34
MCBC 2	2.92	17.5	1.50	38	56	34
MCBC 3	3.14	19.1	1.37	38	59	31
MCBC 4	2.77	20.9	1.33	35	55	35
MCBC 5	5.74	19.0	1.41	37	55	35
MCBC 6	3.46	21.7	1.38	37	55	31
MCBC 7	2.60	19.2	1.22	46	55	30
MCBC 8	3.51	17.1	1.50	40	55	33
MCBC 9	3.76	24.1	1.29	33	51	34
MCBC 10	4.63	22.1	1.18	35	55	27
MCBC 11	4.62	18.3	1.38	43	54	30
MCBC 12	3.03	23.1	1.08	43	59	21
MCBC 13	3.70	21.1	1.23	39	57	29
MCBC 14	3.67	20.0	1.14	35	56	23

Source: Haya, R. *et al*. (2013)

Figure 1 MCB cocoa clones; a – MCBC 10, b – MCBC 14 and c – PBC 123

cultivation to an area of 414 236 ha successfully produced a peak production of 247 000 tonnes of dried beans in 1990 (ICCO, 2008). Although production was high, the field cocoa productivity was considered low with less than 500 kg per hectare per year, mainly due to the unselected cocoa planting materials.

Post 1990s, there was a tremendous decrease in cocoa planting area in Malaysia that led to a decline in cocoa beans production. The main factors for the decline were: pest (cocoa pod borer – CPB) and diseases (VSD and black pod), unstable price and low productivity. In 2016, Malaysia produced only 1 757 tonnes of cocoa beans. Presently more than 95 per cent of the cocoa areas are managed by smallholders with an average farm size of about one hectare.

Although the production of cocoa beans has declined, Malaysia is currently the second largest cocoa processor in the Asian and Oceanic regions and the seventh in the world.

Globally, chocolate and its source, cocoa, are experiencing a moment of change and dynamism. With the rise in high-quality and fine chocolate confectioneries, the processing of beans at countries of origin is highly debated in the European chocolate market now. The main European countries such as Germany and Netherlands imported semi-finished cocoa products mostly cocoa paste (54%), followed by cocoa butter (36%), cocoa powder (18%)

TABLE 4
TECHNICAL INFORMATION OF SOME OF THE MALAYSIAN COCOA CLONES

Clone	*PYT*	*DBY (kg/ha/yr)**	*PV*	*ADBW (g)*	*BNP*	*FAT (%)*	*CPC (%)*
KKM 1	68.4	3930	17.4	1.06	51	56.0	34.0
MCBC 9	90.7	3760	24.1	1.29	33	51.3	33.5
MCBC 1	68.9	3590	19.2	1.3	39	56.0	34.3
MCBC 8	59.9	3510	17.1	1.5	40	54.7	33.1
QH 22	75.1	3510	21.4	1.15	42	55.0	28.3
BR 25	67.3	2690	25.0	1.0	40	45.0	40.5
PBC 123	58.7	2550	23.0	1.04	42	53.0	33.8
KKM 25	72.5	2440	29.7	1.3	24	52.0	39.0
KKM 22	58.1	2420	24.0	1.09	38	57.0	31.0
PBC 139	43.4	2250	19.3	1.18	44	57.0	25.3
KKM 4	51.0	2040	25.0	1.06	38	54.0	36.0
QH 1003	50.5	2030	24.9	1.36	31	53.0	31.9
KKM 5	43.8	2020	21.7	1.07	42	49.0	42.0
PBC 112	38.3	1530	25.0	1.01	38	56.0	27.0

Note: PYT-pod yield per tree, DBY-dry bean yield, PV-pod value, ADBW-average dry bean weight, BNP-bean number per pod, CPC-cocoa powder content
*Based on 1111 trees per hectare
Source: Nuraziawati, M.Y. *et. al.* (2016)

TABLE 5
PERFORMANCE OF COCOA CLONES RELEASED FOR COMMERCIAL PLANTING IN MALAYSIA – COMPARISON

Clone	*Pods (no/tree/yr)*		*Dry cocoa beans (kg/tree/yr)*		*Dry cocoa beans (tonne/ha/yr)*	
	Mean	*Std*	*Mean*	*Std*	*Mean*	*Std*
PBC	38.84	9.50	1.77	0.36	1.97	0.39
KKM	47.40	8.59	2.00	0.29	2.42	0.62
QH	67.18	16.00	2.80	0.56	3.05	0.58
MCB	62.40	20.71	3.27	1.10	3.63	1.22

Source: Lee, C.H. (2013)

and chocolate (2.0%) in 2017 (CBI, 2017). Fine chocolate confectioneries produced in Europe amounted to about 7 million tonnes (worth about €28 billion) in 2017. Single origin beans with value-added products are the main focus by major cocoa producing countries such as Peru, Colombia and Honduras. In Peru as much as 40 per cent of its cocoa exports in 2016 consisted of value-added beans. This development of single origin cocoa products is also reflected by events such as Origin Chocolate, Chocoa and Salon du Chocolat.

TABLE 6
RECOMMENDED COCOA CLONES FOR COMMERCIAL PLANTING

Class	*Clones*
I	KKM 22, MCBC 1, PBC 123, QH 1003, MCBC 8, MCBC 10
II	BR 25, KKM 1, KKM 4, KKM 5, KKM 19, KKM 25, MCBC 9, MCBC 11, MCBC 12, MCBC 13, MCBC 14, PBC 112, PBC 137, PBC 139, PBC 221, QH 22, RP 1
III	BAL 209, BAL 244, DESA 1, KKM 2, KKM 6, KKM 15, KKM 17, KKM 26, KKM 27, KKM 28, MCBC 2, MCBC 4, MCBC 6, MCBC 7, PBC 159, PBC 179, QH 37, QH 326, QH 1176
IV	KKM 3, MCBC 3, MCBC 5, PBC 130, PBC 131, PBC 140, QH 186, QH 240, QH 441, QH 968, QH 1287

Note: BAL (Borneo Abaca Limited, Tawau), BR (Balung River Estate, Tawau), DESA (Koperasi Pembangunan Desa, Sabah), KKM (Klon Koko MARDI), MCBC (Malaysian Cocoa Board Clone), PBC (Prang Besar Clone, Golden Hope Plantation Bhd), QH (Quoin Hill, Jabatan Pertanian Sabah) and RP (Red Pod, SAFIMA Plantation Sdn Bhd, Sandakan, Sabah)

Thus, the rising trend in producing specialty beans or single origin cocoa is the way forward for the cocoa industry in Malaysia.

POTENTIAL ASPECTS OF MALAYSIAN COCOA BEANS QUALITY FROM BULK TO SPECIALTY BEANS

Change of global trend on cocoa beans

The world cocoa market distinguishes two categories of cocoa beans, which are: "fine or flavour", and "bulk" or "ordinary" cocoa beans. The International Cocoa Organisation (ICCO) defines fine cocoa as cocoa that is free from defects in flavour while providing complex flavour profile that reflects the expertise of the producer and the 'terroir' (sense of the particular environment where cocoa is grown, fermented and dried). Flavour cocoa is defined as cocoa that has little to no defects in flavour and provides valuable aromatic or flavour characteristics that have been traditionally important in blends. As a generalisation, fine or flavour cocoa beans are produced from Criollo or Trinitario cocoa tree varieties (Rusconi & Conti, 2010), while bulk (or ordinary) cocoa beans come from Forastero trees. Cocoa bean from Cameroon produced by Trinitario type trees and whose cocoa powder has a distinct and sought-after red colour is classified as bulk cocoa beans. It should be noted that the difference between fine or flavour cocoa and bulk cocoa is in the flavour rather than in other quality factors. Fine flavours include fruit (fresh and browned, mature fruits), floral, herbal, and wood notes, nut and caramelic notes as well as rich and balanced chocolate bases (ICCO, 2018). Today, beans so called 'fine' or 'flavour' cocoa are produced by Criollo and Trinitario varieties which represent only 8 per cent of the total world bean production and thus creating a relatively small but highly-specialised and separate market with its own supply and demand characteristics, as compared to the international market for bulk beans.

Despite fine or flavour beans, certified organic beans have also benefitted from the strong growth in demand largely driven by health consciousness among consumers. According to the ICCO, worldwide production and export

of organic cocoa stood at 15 500 tonnes in 2005. It is certain that organic cocoa market represents only a very small share of the total cocoa market (estimated at less than 0.5% of total production). Even though the market size is small for organic cocoa, the global organic chocolate sales have increased from US$171 million in 2002 to US$304 million in 2005. The Dominican Republic is dominating the organic cocoa market and is currently the world's largest organic cocoa supplier with an annual production of 5 000 tonnes which holds around 70 per cent of the total market share; Peru, Ecuador and Mexico together hold around 20 per cent of the market production share while the rest of 10 per cent is held by Bolivia, Ghana, Brazil and others. Demand for organic cocoa products is very high in the United States, United Kingdom and Germany as these countries are the largest manufacturers of cocoa organic products. Overall, the global cocoa beans market size was estimated at USD9.94 billion in 2018 and is projected to expand at a compound annual growth rate (CAGR) of 7.3 per cent from 2019 to 2025 (*Figure 2*). There are 25 countries recognised by ICCO as the fine flavour producing countries (*Table 7*).

Moving Malaysian cocoa beans in line with global market trend

The market prices for major commodities in Malaysia especially palm oil, rubber and cocoa have been fluctuating and generally has been low. Cocoa had an average price ranging between RM6 - 7 per kilogramme of dry bean in 2020. The low cocoa bean production no longer benefits the stakeholders due to current low bean price. Thus, the thought of shifting bulk beans (quantity beans) over fine or flavour beans (quality beans) is brought about by a niche market demand which contribute to about 5 per cent of the volume of total world cocoa production market, reaching around 70 000 tonnes annually. The share of fine or flavour cocoa in the world production is still relatively small, ranging between 40 - 50 per cent at the beginning of twentieth century, with Ecuador and Trinidad and Tobago being the major fine or flavour cocoa producers, to just over 5 per cent per annum currently. The idea of producing fine or flavour cocoa beans can be a breakthrough in the current market condition with low bean price. This is due to the fact that most of the major chocolate manufacturers have premium quality chocolate products and require fine or flavour cocoa from specific origins in their recipes for the distinct taste or colour of their chocolate. When the planting materials have strong impact on flavour, conditions of post-harvest processing become more demanding and critical in order to compensate for the inherent genetic differences, it is not possible to achieve the

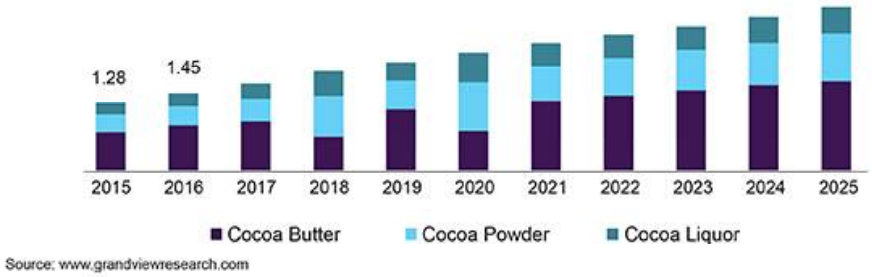

Figure 2 Projection of U.S. cocoa beans market size by product

TABLE 7
LIST OF COUNTRIES WITH RECOGNISED FINE FLAVOUR COCOA BEANS APPROVED BY THE INTERNATIONAL COCOA COUNCIL, WITH COUNCIL DECISION ON SEPTEMBER 2020

Countries	*Share of total exports of the country classified as fine and flavour cocoa (%)*
Belize	a/
Bolivia	a/
Brazil	100
Colombia	95
Costa Rica	100
Dominica	100
Dominican Republic	45
Ecuador	75
Grenada	100
Guatemala	75
Haiti	4
Honduras	a/
Indonesia	10
Jamaica	100
Madagascar	100
Mexico	a/
Nicaragua	80
Panama	50
Papua New Guinea	70
Peru	75
Saint Lucia	100
São Tomé and Principé	a/
Trinidad and Tobago	100
Venezuela, Bolivarian Rep. of	a/
Vietnam	a/

Note: a/ There is a presence of the fine or flavour beans, however, the Panel is unable to evaluate and determine a percentage.

target of West African or Brazilian flavour quality which possesses a good, strong and chocolate flavour. Thus, planting materials developed by the MCB through research and development (R&D) are able to foresee the potential of producing Malaysian fine or flavour cocoa beans. This serves as a tagline/ trademark for Malaysia to produce our own unique specialty fine cocoa beans.

The success of these activities will depend on the ability to overcome the limiting factors in cocoa production and consistency in supplying adequate good quality cocoa beans for the cocoa downstream industry. In this respect,

implementation can be focussed on identifying more varieties of cocoa planting materials with fine or selected flavours. Malaysia has produced more than 50 commercial clones for bulk bean production. From the result of screening based on sensory evaluation, it has been observed that about ten of these commercial clones contain good flavour, in other words, the flavour quality is 80 per cent as good as the standard bean quality from Ghana. There are a few clones that have been recognised to have unique flavours such as spicy and floral.

Thus, with good potential in the fine flavour market, the strategy of implementation should be taking into consideration the fine flavour cocoa value chain and the quality assurance of the fine flavour cocoa. An in-depth market study will be necessary to give more detailed recommendations on fine flavour cocoa investments in Malaysia especially on the pricing, quality and volumes. MCB can take the lead in estimating the potential, variety in use, yield, disease resistance and level of mixing the varieties which can influence the overall quality of the fine flavour cocoa beans. For quality assurance, MCB can provide knowledge on the production of the fine flavour beans and post-harvest management.

In order to succeed as an integrated production system in the value chain for selected fine flavoured cocoa, the cooperation and collaboration of the medium and big plantation players, MCB R&D Centre, the farmer's organisation and the level of local processing are required.

The concept "from fine bean to premium bar" can be realised through technology and knowledge transferred by MCB to the key market players, either in establishing new cocoa planting areas with only fine cocoa varieties, or improving existing cocoa farms at the potential smallholders' area by mature grafting of selected cocoa clones. The R&D Centre in MCB can also be transformed to produce certain amount of fine or flavour cocoa beans and become the pilot plant to lead the success.

As a comparison between bulk beans and fine or flavour beans in terms of market bean price and estimated income, fine or flavour beans show a huge potential in the current market. The average price for bulk beans across all four classes is RM6.50 per kilogramme while for the fine or flavour beans, the price is estimated to be RM17.50, which is more than double (*Table 8*).

Currently, there are a few local chocolatiers in Malaysia who is buying good quality beans with specialty flavours at higher price ranging from RM8.50 to RM16.00 per kilogramme which are higher than the market price.

The higher price from the good quality beans can help to compensate the lower production in Malaysia. Recently, one of the local chocolatiers from Malaysia, who was also a winner of the Cocoa of Excellence (CoEx) Award in 2011 for high cocoa flavour of beans, won a bronze medal at the International Chocolates Awards with the drinking chocolate made from cocoa beans originating from Sungai Ruan in Pahang.

Malaysian cocoa beans in a global scenario?

Cocoa beans produced by various planting materials have their own characteristics flavour. They are used mainly for manufacturing specialty chocolate, usually from a blend of different varieties of cocoa beans in order to give a distinctive flavour profile to their finished chocolate.

The factors that contribute to flavour differences are genetic background, post-

TABLE 8
COMPARISON OF MALAYSIAN BULK AND FINE FLAVOUR BEANS ACCORDING TO CLASSES FOR AVERAGE DRY BEAN YIELD AND ESTIMATED INCOME

Cocoa varieties	*Average dry bean yield (kg/ha/yr)*	*Estimated income (RM/ha/yr)**
Bulk beans		
Class I (tolerant to P&D)	2118	13767
Class II	2586	16809
Class III	2438	15847
Class IV (susceptible to P&D)	2988	19422
Average	2532	16461
Fine or flavour beans		
MCBC 9	3760	65800**
MCBC 12	3030	53025
MCBC 14	3666	64155
MCBC 15	1321	23117
QH441	3880	67900
PBC 140	1680	29400
Average	2889	50566

*Using average price range at RM6.50/ kg
** Using average price range at RM17.50/ kg
Source: Aizat *et al.* (2020)
The six fine flavour clones will be officially launched in 2021

harvest practices as well as soil and climatic conditions. The CoEx aims to recognise and promote the diversity of cocoa flavours to produce high quality cocoa. Malaysia received several awards including the CoEx and those winning cocoa varieties are commercial clones identified by the MCB. The CoEx programme started in 2009 spearheaded by the Alliance of Biodiversity International and CIAT gave awards for quality, flavour and diversity of cocoa according to the origin. In Malaysia, commercial cocoa clones can be divided into four classes, corresponding to the quality standards according to the genotype (size and weight) and phenotype (post-harvest) of the seeds. More than 95 per cent of bean contributors in Malaysia are the cocoa smallholders. Therefore, smallholders should be encouraged to plant more of the commercial clones recommended by MCB.

Malaysia has been participating in several series of CoEx Programmes and International Cocoa Awards (ICA) since 2010 and had been awarded the ICA four times i.e.in 2011, 2013, 2017 and 2019 (*Table 9*). The event is the platform for cocoa producing countries to promote the values of their beans through recognition of their quality, flavour and diversity of cocoa according to their origins. This is also a Malaysian effort to evaluate and investigate the flavour of Malaysian cocoa beans with improved post-harvest process. From the programme, Malaysia has been globally recognised as one of the best cocoa producing

TABLE 9
COCOA OF EXCELLENCE AWARDS (COEX) AND RECOGNITION RECEIVED BY MALAYSIA

Year of award	*Number of participants*	*Number of samples in top 50*	*Number of samples that received International Cocoa Award (ICA)*	*Sample origin*	*Cocoa variety*
2011	7	2	2 (Spicy and additional awards; chocolate)	i) Serian, Sarawak - Spicy and additional awards ii) Raub, Pahang - Chocolate	Mixed Trinitario
2013	8	4	2 (Spicy; chocolate)	i) Bintulu, Sarawak - Spicy ii) Kapar, Selangor - Chocolate	Mixed Trinitario
2015	8	1	*None*	i) Ranau, Sabah - Chocolate	Mixed Trinitario
2017	7	2	1 (Chocolate)	i) Jerantut, Pahang - Chocolate ii) Ranau, Sabah - Chocolate	Mixed Trinitario
2019	6	1	1 (Cocoa attribute with dried and browned plum or cherry notes, some fresh fruit notes, ripe tropical fruits and slight floral notes for cocoa liquor sensory evaluation; and for the chocolate sensory evaluation - nuts and mild browned fruits aroma)	i) PPPK Bagan Datuk, Perak	Mixed Trinitario

Source: http://www.cocoaofexcellence.org

countries with fine flavour characteristics as indicated below:

- In the 2011 CoEx edition, Malaysia received the ICA for spicy and high cocoa flavour under the South East Asia and Oceania region category. The awarded samples were from Tebakang, Sarawak with spicy flavour (Mr Cyril Ak Langin) and from Raub, Pahang with high cocoa flavour (Mr Koh Ah Kau). In this 2011 edition, a total of 119 samples from 22 producing countries participated for the recognition.
- In the 2013 CoEx edition, Malaysia was awarded the ICA for two samples; Kapar, Selangor with high cocoa flavour (Tn Hj Ahmad Sapari) and Bintulu, Sarawak with spicy flavour (Mr Janda Ak Jelian) under the Asia and Pacific region category. As many as 121 samples of 24 producing countries participated at this 2013 event.
- In the 2015 edition, Malaysia was listed under the best 50 samples from 146 samples of 35 participating cocoa-producing countries. The sample was from Ranau, Sabah with high cocoa flavour specialty (Mr Nujarin Angadong).
- In the 2017 CoEx edition, Malaysia received the ICA for high cocoa flavour attribute under the Asia, Pacific and Australia category. The sample was from Jerantut, Pahang (Mr Teo Chun Hoon). The cocoa bean sample from Ranau, Sabah (Mr Jonisin Tambi) was listed under the best 50 samples with high cocoa flavour specialty. About 166 samples from 40 producing countries participated in the 2017 event.
- In the latest edition (CoEx 2019), a total of 223 cocoa bean samples from 55 producing countries participated for the award. Malaysia received the ICA for cocoa attribute with cherry and fresh fruit notes flavour under the Asia, Pacific and Australia region category for the sample from Cocoa Research and Development Centre of Bagan Datuk, Perak which was evaluated by the CoEx Technical Committee and panel of professionals.

FACTORS CONTRIBUTING TO SPECIALTY BEANS

Planting materials selection from germplasm in Malaysia

Earlier, the selection of good cocoa planting materials was based mainly on agronomic traits such as high yield, good pod and bean characteristics, resistance to pests and diseases and high butter content. Later, flavour characteristics of cocoa beans were emphasised since there is a high demand for fine flavour cocoa in the global market and the crops should be able to satisfy buyers' quality specifications especially from the chocolatiers.

The main cocoa varieties that are commercially used to produce food and beverages are Forastero, Criollo, Trinitario and Nacional. Forastero group is classified as bulk, basic or ordinary cocoa grade that shows strong basic chocolate flavour which represents over 90 per cent of the world cocoa production. The fine grade or flavour cocoa is produced from Criollo, Trinitario and Nacional varieties, representing about 5 - 10 per cent of world cocoa production and mainly used for dark chocolate manufacturing. The Criollo variety which is rare to find is highly aromatic cocoa

with fine flavour characteristics such as nutty, fruity, flowery, or tea-like flavours. The Trinitario which is the hybrid of Criollo and Forastero varieties produces strong basic chocolate characters and some wine-like flavour. While, Nacional group which is only grown in Ecuador presents the Arriba flavour with aromatic, floral, spicy, and green notes.

Malaysia has about 1000 genetic materials throughout its regions. In the Malaysian cocoa germplasm collection, most of the varieties are from the Trinitario and Forastero types. These collections provide important and good repositories to obtain breeding materials for crop improvement.

To produce superior cocoa planting materials with fine or good flavour is one of the cocoa breeding objectives in Malaysia. The comprehensive cocoa breeding works involve the importation of potential genetic materials, assessment and evaluation of the materials, hybridisation process, setting up several progeny and clonal trials, selection of the potential and superior materials and finally the production of the end product (superior planting materials with specific traits) for commercial utilisation.

For commercial plantings throughout Malaysia, the MCB has offered a total of 53 cocoa clones with special characteristics and suitable environments and planting conditions. Through cocoa liquor sensory evaluation conducted, there are six clones with distinctive fine flavour as listed in *Table 10*. These fine flavour clones will be officially launched this year (2021).

These six fine flavour Malaysian cocoa clones are recommended for planting with the objective to produce cocoa beans with fine and good flavour cocoa. However, clone PBC 140 is very susceptible to VSD disease and should be avoided for planting under moist condition and environment.

TABLE 10
FINE FLAVOUR MALAYSIAN COCOA CLONES

No	*Clones*	*Flavour note*
1	MCBC 9	Cocoa and floral
2	MCBC 12	Cocoa, fresh fruit and floral
3	MCBC 14	Cocoa and nutty
4	MCBC 15	Cocoa, nutty and fresh fruit
5	QH 441	Cocoa and spicy
6	PBC 140	Cocoa

Post-harvest process

In Malaysia, cocoa grading and certification scheme has been launched and applied by the cocoa sellers whereby all exported cocoa beans are required to follow the Standard Malaysian Cocoa (SMC) label. This scheme has been initiated to monitor the quality of Malaysian bean is at acceptable level and the grading scheme is specified and certified by the Standard Industrial Research Institute of Malaysia (SIRIM). Since 1984, the Malaysian Standards established are the MS 293 – specification for grading cocoa beans and MS 230 for sampling of cocoa beans. These standards followed the International Standards ISO 2451-1973 – specifications for cocoa beans; ISO 2291-1980 – determination of moisture content for cocoa beans; ISO 1114 - 1977 – cut test for cocoa beans and ISO 2292 - 1973 – sampling for cocoa beans. Currently, the revised version of Malaysian Standards for cocoa beans - specification (MS 2672: 2017) is being followed. The grading and certification scheme has brought about a significant improvement in the quality of cocoa beans exported. There are three grade specifications i.e. based on bean count and defect levels (SMC 1, SMC 2 and SMC 3) as for fine or flavour cocoa, beans must fall under SMC 1.

For SMC 1, the bean count must be less than 100 in 100 g of beans, the percentage of mouldy beans not more than or equal to 3 per cent, slaty beans not more or equal to 3 per cent and insect damaged and germinated beans not more or equal to 2.5 per cent.

In Malaysia, cocoa beans with SMC 1 follow the practices recommended by the MCB. Unripe pods are usually green or red and harvesting can be done when the pods turn yellow or reddish. Pods are harvested using scateurs, sharp curved knife or scissor-like tools attached to a long pole for pods which are difficult to reach by hand. Hand picking is avoided. Pod collection must be carried out on the same day or the following day. Pod breaking is done in the field or sites adjoining fermentation centres using knife or blunt tools. Beans that are accidentally damaged/cut during pod breaking will be removed because damaged beans might cause the development of low flavour precursors in the dried cocoa beans. Fermentation of fresh beans are initiated on the same day after pod breaking with a minimum of 25 kg wet beans using a fermentation shallow box (*Figure 3*) about 30 cm deep and is covered with a gunny sack or banana leaves. Good quality beans with fine or flavour characteristics is achieved when the temperature of the fermenting mass increases from room temperature to more than 42°C and decreases at the end of fermentation process (*Figure 3*).

Good fermentation is important for oxidation and condensation reactions to form new and large insoluble tannin compounds which give the characteristics of brown colour to the beans. Thus, it is essential to stop the fermentation at the right time by drying; otherwise over-fermented beans with dark colour will be produced. Recommended duration for the Malaysian Standard process is 5 days with turning once on the third day. Beans are dried under the sun and must be

Figure 3 A shallow wooden fermentation box presents beans with complete fermentation process

periodically turned every 2 - 3 hours. Sun drying is completed in 4 - 7 days depending on the weather. Dried cocoa beans are stored using gunny sacks, properly tied and kept in a cool and dry place.

IDENTIFICATION OF FLAVOUR ATTRIBUTES IN MALAYSIAN COCOA CLONES

Currently, the flavour attributes of beans in Malaysia are defined by organoleptic tests. The MCB has well-trained sensory panelists to evaluate flavour attributes, including cocoa, bitter, astringent, acid/sour and fruity/floral/ bouquet. High-throughput of advanced analysis tools, for instance, powerful DNA fingerprinting technique which is one of the rapid and accurate methods, needs to be developed for identification of fine or flavour beans. This would benefit the smallholders to get higher prices; the cocoa traders and exporters in grading and certifying beans at the source of origin and the manufacturers in buying beans from unreliable sources. The use of molecular marker is also preferred for rapid and efficient identification because the expression is not affected by environmental conditions and age of the plants.

Cocoa seeds are the raw material in chocolate manufacturing and beans with special aroma derived from seed endogenous components, including storage proteins and carbohydrates, have always been linked to the fruit pulp but detailed information on its molecular background is still lacking. Thus, a study is being conducted to identify volatile components with flavour characteristics using gas chromatography mass separation (GCMS). A recent study by Kadow *et al*. (2013) identified volatile compositions existing in fine or flavour cocoas (SCA6, EET62) which differentiate from bulk cocoa (CCN51). The monoterpenes β-myrcene, β-trans-ocimene, β-cis-ocimene and β-linalool in SCA6 and secondary alcohol 2-heptanol, its ester 2-heptanolacetate and the methyl ketones 2-heptanone and 2-nonanone in EET62 contributed to fine aroma.

CONCLUSION

Malaysia has good potential for specialty cocoa beans with organic and specialty beans being identified. However, its weaknesses are pest and diseases, high labour cost, aging farmers and weak governance. Another weakness is non-existing market for specialty cocoa export and no extensive fine flavour cocoa market. However, the strength is the premium price offered by the chocolate manufacturers thus giving a good incentive for farmers to have good agricultural and post-harvest practices. Opportunities for the specialty cocoa industry could be by providing a good quality control system with more involvement of the government and manufacturing companies. Developing 'bean to bar' of specialty cocoa could also help to improve the quality of life of local farmers with better income from premium cocoa beans. Shortcomings include the need to introduce more varieties with higher yields and better pest and diseases tolerance to the farmers.

The growing health concern among consumers has also driven up the demand for traceable organic specialty cocoa. The common perception is that organic chocolate reduces the consumer's exposure to artificial chemicals and pesticides. Certification is another requirement by specialty cocoa buyers and retailers as an important proof of commitment to sustainability.

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