

Cocoa Commodity Safety Reviews

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Although Indonesia has become the third largest cocoa producer in the world; the quality and quantity of cocoa exports are claimed to decline progressively since the last few years (Republika, October 20, 2008). Cocoa price instability in world markets is one of the problems that often become the scapegoat for these declining trends.

However, we often forget when quality also determines the price. Several accidents of automatic detention have been issued for cocoa products from Indonesia, mainly in Europe and America. From the standpoint of quality, we must recognize that there are fundamental issues that need to be addressed for our cocoa commodity.

Good cocoa beans, according to the standards of world trade is fermented perfectly, has distinctive smell of cocoa, does not contain physical dirt, insects, and fungi. Tolerance limits of off-grade allowed is less than 3% of the total weight.

Based on observations and research outcomes of cocoa in Indonesia and the world, problems of quality cocoa beans can be divided into several large groups: falsification of quality (adulteration), pesticide residues and heavy metals, enteropathogens and *Salmonella* bacteria, fungi and mycotoxin, as well as the latest issue of advanced glycation ends (AGE) compounds as by-product of roasting cocoa.

Physical Safety

Adulteration is the main problem in Indonesia cocoa commodity. Empty shells of cocoa, finely cut twigs, and fine grains of soil and rock are often found as adulterant. Fraudulent practices generally occur in the level of farmers and collectors who want to increase weight of the end product. In Indonesia, there seems no data for quantification of adulteration of cocoa products from farmers, collectors, until big traders.

Chemical Safety

Pesticide residues in cocoa products mainly occurred in large-scale monoculture plantations. However, there is also possibility of small cocoa plantations in Indonesia to apply large amounts of pesticides to overcome the attacks of vascular streak dieback (VSD) and cocoa pod borer (CPB). Although cocoa beans are not directly exposed to pesticides, residue will settle to the ground. Cocoa will be affected by pesticides during fermentation process, which is generally performed on a bare ground tarp.

Cacao plantation located in mining areas, for example in East Kalimantan, will be vulnerable to heavy metal contamination accumulated in the soil, air, and water. A study in Canada explained that cocoa shells can be very efficiently absorbing heavy metals in acidic conditions (fermentation). This proves that there is potential danger of heavy metal content which can occur if the fermentation process of cocoa plantations carried out in a polluted environment.

Microbiological safety

ICMSF (2005) highlights *Salmonella* and entero-pathogenic bacteria as the main focus of microbiological safety either in cocoa bean products, powder, or chocolate bar. Acid resistant strains of *Salmonella* generally survive and use sugar, protein and fat in cocoa beans. Due to its aggressiveness, *Salmonella* is a very dangerous species of bacteria in a

very low dose of infection. Standard of Salmonella in cocoa products is not detected in 25 g sample. Meanwhile, entero-pathogenic bacteria contaminate and survive since the beginning of post-harvest processes. Hands of workers, equipments and contaminated soil are the main source of these bacteria in cocoa products (Da Silva do Nascimento, et al, 2009).

In our study (Rahmadi and Fleet, 2007), populations of fungi on the dried product of cocoa beans from Indonesia after fermentation and sun drying are ranging from 2×10^4 to 7×10^6 colonies per gram sample. Among the dozens of fungi species isolated, *Aspergillus flavus* and *Aspergillus niger* dominate the micro-flora on dried cocoa beans. About half of the *Aspergillus flavus* strains are known to produce Aflatoxin, while *Aspergillus niger* currently known to also produce Ochratoxin A. Several publications in 2003 to 2007 mention mycotoxin contamination levels in cocoa products could reach 4 µg per kg product, slightly below the threshold set by the European Trade Commission in food products, which is in general should be less than 5 µg per kg.

Mycotoxin in all food products, especially grains and legumes, becomes a hot topic in recent years, given the stability in processing and ability to induce degenerative diseases such as liver cancer and Alzheimer's disease. European Trade Commission has tried several times to discuss the contamination limit of mycotoxin on cocoa products, and it is possible to establish these standards in the near future for all imported cocoa beans, including from Indonesia.

GFP for prime quality of cocoa

We should admit that cacao commodity production is still experiencing a lot of quality problems. It seems that we need to make realistic efforts, which are more than just seminars and symposia. These problems can generally be overcome by application of Good Farming Practises (GFP), which may be inconvenient at the operational level but still feasible.

The process to produce prime quality of cocoa beans starts from the earliest stage, cocoa plantation. Cacao fruit produced from certified seeds and manicured gardens is the beginning of the quality assurance of this commodity. From the aspect of post-harvest, top quality cocoa beans is determined from three aspects, healthy cacao fruit, a successful fermentation, and a quick and accurate drying stage.

In some best practice cacao fruit maturation, each fruit is protected with a plastic bag to prevent the outbreak of disease and pest attacks. Diseases of cacao fruit are generally transmitted between fruit very quickly, so weeding cacao fruit is a routine thing to do. A combination of weeding and protecting cacao fruit will also reduce the use of pesticides on cocoa plantations. Furthermore, cacao fruit must be harvested timely and cocoa beans is immediately issued from the fruit.

Beans that are still shrouded in white mucilaginous pulp are spontaneously fermented for about one week, carried out in a box or on a heap. The fermentation process begins with the growth of ethanol producing yeast such as *S. cerevisiae* and *Kloeckera sp.* Ethanol is a prime source of food for vinegar acid-producing bacteria, *Acetobacter*, which dominate the next stage of fermentation. Vinegar-making stage is marked by an increase in temperature, where the combination of warm temperatures and the high concentration of acid will kill cocoa germs. The smell of cocoa is formed as a result of breaking down complex components with the help of enzymes secretion from many species of bacteria and yeasts. Toward the end of the fermentation process, spore producing bacteria and filamentous fungi often emerge and are generally not preferred, because some of them can produce toxins.

The early stage of natural fermentation is critical due to competition of microorganism growth, wherever possible to minimal pathogen contaminations and toxin-producing fungi. Inductive fermentation with mixed cultures assistance is encouraged to produce more uniform products as well as to reduce the number of unwanted microorganisms.

Successful fermentation indicated by colour change in cocoa beans from purple to brown, a distinctive aroma of cocoa, and clean (non sticky) beans. Many suggested that after the fermentation process is over; cocoa beans are washed half-clean to remove bacterial spores and fungi on the surface. Half-clean wash would reduce the number of microorganisms to the amount that is still enough to help the formation of cocoa flavour during the drying process.

Drying cocoa beans is best practiced at temperature below 60 °C with a mechanical dryer or under the bright sun light. Drying should take place quickly enough to prevent the growth of fungi and spore-producing bacteria. Fungal spores and bacteria that already deposited are not inactivated in further processing of cocoa beans. Critical point of drying is not exceeding 60 °C, drying duration is not more than three days if using the sun light or 18-24 hours when using a mechanical dryer, as well as the end product moisture content is about 6-8%.

The cacao bean is highly hygroscopic (absorbs moisture from the environment), so that proper processes of packaging and storage in the level of farmers, collectors and wholesalers become important. Cocoa beans have to be avoided from excessive humidity and where possible are quickly processed into powder products or cocoa butter. The critical point of moisture levels recommended to prevent the proliferation of fungal and bacterial pathogens in dry cocoa beans is 6-8%. To prevent high humidity and to avoid contamination, it is best to use clean bags, not containing pesticides or fertilizers, and have pores to come out into the air.

Perfectly fermented cocoa beans, no insects and fungal contamination, produce high economical value. High quality cocoa does not need adulteration. Many countries provide subsidies at the level of farmers to maintain the quality of agricultural products, including cocoa. Active role of Cacao Growers Association and co-operation with cocoa processing company become an important factor in preventing adulteration on cocoa commodity. Long chains of trading of cocoa products from farmers to processing companies also require attention and improvement in government regulation.

The emerging safety trends: AGE

Technology development and characterization of chemical molecules bring a lot of new things that can improve the quality of human life. One example of the most current and surprising research publications is the influence of simple by-product molecules of food processing to health.

Advanced glycation ends (AGE) is a derivative product of the interaction of sugar with protein, amino acids, or fat. One in hundred molecules has the probability to form AGE ligand that is capable to proliferate healthy cells into cancer cells, increases levels of oxidative stress in cells, causes inflammation and triggers early aging. Until now, AGE has been shown as one of the causes of atherosclerotic disease, diabetes, renal failure, and degeneration of brain cells (Goldberg et al, 2004).

AGE was produced in the body and is useful as a means of intercellular communication. However, these simple peptide molecules are also present in significant amounts in food products, mainly food prepared with heat at high temperatures. AGE is also a side product in the Maillard reaction that generally occurs in late stages of fermentation of cocoa beans. Cell activity can increase three to four times as induced by AGE, originated from chocolate bars (Gawlowski et al, 2009). AGE in chocolate products can be derived from

two main processes, during fermentation which non-enzymatic browning occurs and roasting process. In the late stage of fermentation, proteins and free amino acids will experience destruction and degradation, some of which interact with the simple sugars to form AGE. As a matter of fact, these two processes are crucial in producing chocolate aroma. Fermentation lowers astringency due to the high polyphenol contents, breaking complex molecules into aromatic precursors. Roasting will strengthen the scent, changing most of the aromatic precursors to pyrazine.

Fortunately, cocoa has high enough levels of polyphenols and they are active, so that AGE levels in roasting cocoa not as high as the AGE in roasting nuts. However, efforts are also needed to improve roasting process of cocoa beans. To reduce the potential formation of AGE, cacao beans must be roasted at a defined temperature and period. Cocoa beans that are burnt or being prolonged exposed to the heat will tend to have higher level of AGE.

Closing

With the increasing quality of human life, the demand for safe products is also increased. Chocolate as food and raw materials are a popular food in the world. Implementation of good farming practises and manufacturing processes, that continually be improved, is a must in an effort to increase the safety of cocoa commodity and its derivatives. Indonesia, as part of the global community and the third largest cocoa producer in the world, certainly is subjected to improve the quality of these commodities.

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