

Strategy to minimize the risk of rejection due to mycotoxin contamination: case for Indonesian nutmeg

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Abstract. Nutmeg seed is one of the Indonesian export products to the European Union (EU). However, due to series of non-compliance since 2016, in 2022 the EU imposed a 30% regulatory check for nutmeg consignment originating from Indonesia. This stricter control resulted in higher number of non-compliant batch/lot in the period of 2022-2023, and therefore, it is of importance to formulate a strategy to decrease the non-compliance. Desk study and interviews were conducted to obtain information on border rejection, health certificate application, and the underlying factor causing border rejection. The analysis on performance of sampling plan and the probability distribution were used to recommend the suitable strategy fit for the purpose. To decrease the number of non-compliance, and thus border rejection, the competent authority needs to reduce the prevalence of high contamination level by implementing sufficient measures. Of two possible measures, controlling raw material is able to reduce non-compliance by 80%. To control the raw material, the exporter is required to source a good quality raw material and implement Hazard Analysis Critical Control Points (HACCP). These selected measures shall be made mandatory and should be implemented gradually within 5 years, considering the readiness of the exporter and the whole nutmeg production support system.

1. Introduction

Nutmeg seed is one of Indonesia's export products, in which the export to several countries account for in average 19.807 ton or equal to around 114 million USD per year. However, due to its characteristics, nutmeg seed is prone to fungal attack, and therefore having high risk of contamination with fungal metabolites, such as mycotoxin. Over a hundred thousand of known fungi, only few are reported to produce most concern mycotoxins, namely *Aspergillus* spp., *Penicillium* spp., and *Fusarium* spp. [1]. Among these mycotoxins, the most potent are aflatoxin B1, ochratoxin A and fumonisin [2].

Starting in 2016, the European Union (EU) required that nutmeg consignments originating from Indonesia should be accompanied with Health Certificate (HC) issued by competent authorities in Indonesia. The certificate requires that a batch/lot nutmeg must contain aflatoxin B1, aflatoxin total, and ochratoxin A less than 5 ppb, 10 ppb and 15 ppb, respectively, as stipulated in the EC regulation 1886/2006, and should be produced following good practices along the food production chain. However, again in mid of 2022, EU put additional pressure on Indonesian nutmeg by increasing regulatory

check by 10%, from 20% to 30% due to numbers of non-compliant lots between 2016 and 2022.

This situation provides a great challenge for the exporter, since non-compliance means rejection and the rejected product will be re-exported to the country of origin or destroyed depending on the rules applied in the importing countries. Not only that the rejection has consequences on the financial loss for the exporter, but also on the reputation for the safety of Indonesian nutmeg. In order to decrease the regulatory check imposed by EU, the total number of nutmeg border rejection each year should be lowered. Therefore, government as a regulator should have strategy to minimize the risk of border rejection currently encountered by the exporters. Options to prevent the manifestation of mould, and thus preventing the mycotoxin production are available, such as the use of drying technology or hermetic packaging at producer level. However, no authority intervention, in the form of mandatory measures, implemented at exporter level to minimize the risk of mycotoxin (aflatoxin B1, aflatoxin total, and ochratoxin A) contamination. The exporter implements different strategies, but up to now these are not sufficient to prevent the likelihood of border rejection. Therefore, in this paper different options are explored and the optimal strategies are recommended

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for the authority to be implemented at exporter level to minimize the risk of nutmeg border rejection.

2. Methods

2.1 Data collection

Border rejection information and the health certificate data was obtained from Rapid Alert System for Food and Feed (RASFF) windows portal and the National Food Agency. Offline and online interviews and/or visits were conducted in exporters associated with EU border rejection in 2021 and 2022 to collect information on the handling of nutmegs and possible sources of contamination.

2.2 Data analysis

The interviews data were analysed descriptively. The performance of the sampling plan used to take the nutmeg sample, following EU regulation 519/2014, was assessed using the following equation:

$$PA = (1 - \text{the proportion of defective})^n \quad (1)$$

where, PA or the probability of acceptance is the probability that contaminated samples is not detected, the proportion of defective is the proportion of contaminated batch/lot and n is the number of samples taken from the batch/lot. The performance of sampling plan and the probability distribution were calculated using Microsoft Excel.

3. Results and discussion

3.1 Nutmeg handling and production at exporter level

Figure 1 showed the typical nutmeg production stages at exporter level. However, these stages might be different for each of the exporters, for example not all of visited exporters used UV light screening to further screen the present of mycotoxin. The nutmeg production starts with the incoming of the shelled and in shelled nutmeg. The exporters obtained nutmegs from different parts of Indonesia, among others are Sulawesi and Maluku Islands. Each batch of the incoming nutmeg were checked randomly using a rapid aflatoxin test kit. The incoming batch were then stored in a storage area, with controlled temperature and % Relative Humidity (RH) to minimize the growth of the mycotoxin producing mould. This practice, however, is not uniformly implemented in all exporter, in which some of them store the raw material in non-controlled storage room, equipped with ventilation to allow for better air circulation.

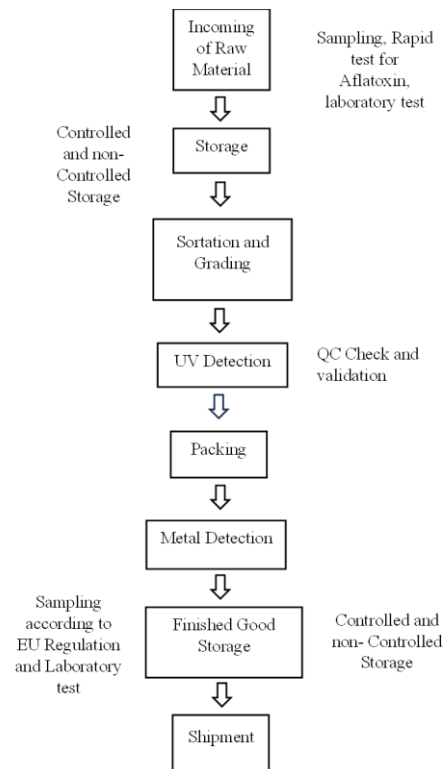


Fig. 1. The nutmeg production stages at exporter level.

Just before the sortation and grading, a nutmeg shell remover machine is used to separate nutmeg seed from its shell, if the incoming raw material is in-shelled nutmeg. Then, the manual sortation and grading is conducted to remove the nutmeg having visible mould contamination and to separate the nutmeg based on export qualities, among others are shrivelled, cracked or broken, and ABCD grades. After manual sorting and grading, the nutmeg was then further sorted manually using the Bright Greenish Yellow Fluorescence (BGYF) method by passing the nutmeg through a chamber equipped with UV light having a specific wavelength (365 nm) located in a dark room. When expose to UV light, aflatoxin B1, B2, G1, and G2 exhibit a bright greenish-yellow fluorescence, which can be used as an indication for the presence of aflatoxin in nutmeg [3]. The same wavelength could also be used for ochratoxin A, which emits a blue-green fluorescence under the UV light [4].

The BGYF method relied on the fluorescence exhibit by the interaction between kojic acid produced by aflatoxin producing *Aspergillus* species and peroxidase enzyme present in nutmeg. Therefore, this method might give a false positive when there is no aflatoxin in nutmeg, but the BGYF is seen due to the presence of kojic acid, and a false negative due to the absence of peroxidase enzyme [5].

This manual sorting is also heavily relied upon the expertise of the workers on recognizing the BGYF, and therefore validation should be in place to minimize the false negative result. However, this method has difficulty to detect aflatoxin formed inside the whole nutmeg. It usually happens if the whole nutmeg has a

hair like cracked, allowing the mould to have access to nutmeg inside and form mycotoxin.

After the UV sortation, the presumptive good nutmegs (finish goods) are packed in polypropylene bags and passed through the metal detector. In some exporter, the nutmeg is steamed or High Temperature Short Time (HTST) sterilized to eliminate the microorganism, including aflatoxin producing species originally presence in nutmeg, so the growth during storage and shipment could be minimized. The non-thermal sterilization, such as irradiation, can also be used for nutmeg, but the application is not yet massive for food product due to consumer acceptability [6]. However, gamma irradiation of 10 kGy was reportedly not sufficient to eliminate the spores of *Aspergillus flavus* and triggered the surviving toxigenic strains to produce aflatoxin B1 [7].

The finished good is then placed in a storage room, and the exporter contacted a local competent authority for the issuance of the health certificate required for nutmeg export to EU [8]. Upon receiving a request, a competent authority performs sampling using a sampling plan according to EU regulation 519/2014 [9]. The samples are then sent to an accredited laboratory, and once the analysis is completed, the laboratory sends the results directly to the competent authorities. The competent authority issues a health certificate when the level of aflatoxin B1, aflatoxin total and ochratoxin A is less than the legal limit set by the EU.

Each of the exporter sending their products out to EU has a Good Manufacturing Practices (GMP) and sanitation hygiene-like certificate called as “Sertifikat Penerapan Penanganan yang Baik” (SPPB) (minimum level is B) issued by a food safety competent authority. Besides the SPPB certificate, some also have the food safety certification system of ISO 22000. In the case that an exporter poses the ISO 22000 certificate, the recognition scheme applied, in which the exporter qualified for the SPPB certificate of a level A. The implementation of GMP and hygiene and sanitation along the production stages at the exporter level minimize the risk of contamination and re-contamination with toxigenic mould, and therefore decrease the likelihood of aflatoxin and ochratoxin contamination during the whole chain of production process.

3.2 The performance of sampling plan and the impact of increased border check frequency on border rejection

Since July 2012 Indonesian nutmeg has been a subject to an increased frequency control at EU border level in regard to aflatoxin and ochratoxin A contamination. However, no improvement could be seen after several years of increased frequency of control, and therefore besides the measure of a 20% border check, starting from 2016 all nutmeg consignments from Indonesia should be accompanied by a health certificate. Table 1 showed that the notification of border rejection increased to 24, with 12 of them are due to lack of health

certificates after the new measure was implemented. In 2022, the EU authority increased the frequency of the official control from 20% to 30%, following the situation of non-compliance after 2016.

Table 1. Notification on nutmeg export to EU.

Year	Border Rejection	Alert	Information
2013	6	1	1
2014	3	-	4
2015	6	1	1
2016	24	-	2
2017	5	1	-
2018	2	-	1
2019	7	1	-
2020	3	-	-
2021	10	-	-
2022	10	-	-
2023	14	-	-
2024*	5	1	-

*until September 2024.

The health certificate was issued by the competent authorities when the analysis result complies with the EU regulation on the limit of aflatoxin B1, aflatoxin total and ochratoxin A. For the analysis, the samples were taken from nutmeg batch/lot following the sampling plan set in EU regulation 519/2014 (Table 2). The number of the bags, from where the incremental samples are taken, were usually randomly generated using Microsoft Excel program.

Table 2. The number of incremental samples to be taken from the lot (EU regulation 519/2014).

Lot Weight (tonnes)	No. of incremental samples	Aggregate sample weight (kg) (in case of retail packings, weight of aggregate sample can diverge)*	No. of laboratory samples from aggregate sample
≤ 0.1	10	2	1 (no division)
>0.1 - ≤ 0.2	15	3	1 (no division)
>0.2 - ≤ 0.5	20	4	1 (no division)
>0.5 - ≤ 1.0	30	6	1 (no division)
>1.0 - ≤ 2.0	40	8 (<12 kg)	1 (no division)
>2.0 - ≤ 5.0	60	12	2
>5.0 - ≤ 10.0	80	16	2
>10.0 - ≤ 15.0	100	20	2

*200 g for each incremental sample.

The compliance with EU regulation, as the basis of the health certificate issuance, means that the result of analysis is less than the stipulated limit. However, while a non compliant result means that the sample is contaminated with a high level of mycotoxin and so is the batch/lot, a compliant result does not mean the opposite. In this case, it is the sample that comply to the regulation, but not all the nutmeg in the batch/lot. There is still a probability that a compliant batch/lot having nutmeg with high level of mycotoxin, but this kind of nutmeg is not sampled due to the non homogenous distribution of the contaminant. Figure 2A shows that the performance of sampling plan increases when the proportion of defective (contaminated samples) or the number of samples is getting bigger. When the proportion of defective samples is 0.05 (1 in 20 bags is contaminated) and the number of incremental samples are 40, there is around 12.9% probability that the contaminated samples is accepted. It means that the compliant batch/lot does not really comply with the limit set in the regulation. Unless all nutmegs in the batch/lot are sampled and analysed, one cannot really certain on the negative outcome (compliant) of a batch/lot . When no improvement is being performed, assuming that the prevalence of contamination is similar, the increase in the frequency of border check will increase the likelihood of border rejection (figure 2B). Therefore, to decrease the rejection rate, the prevalence of contamination should be decreased.

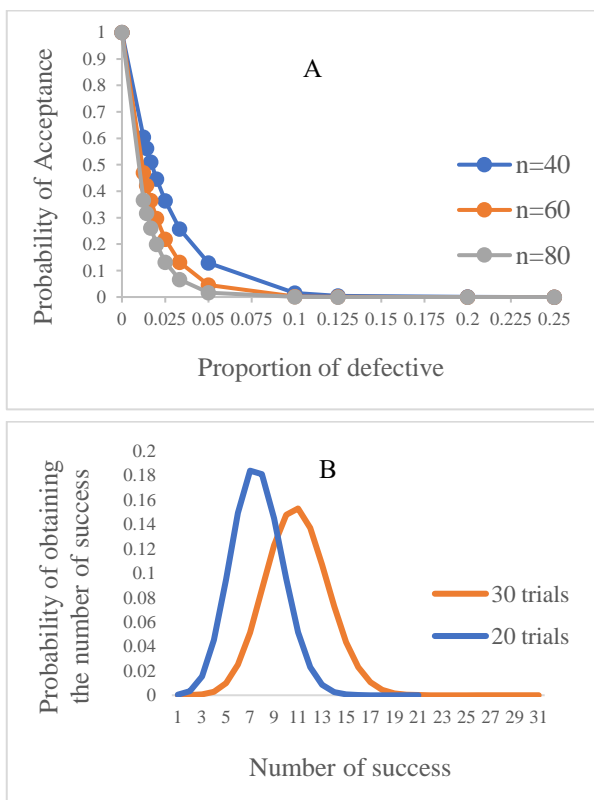


Figure 2. A. Performance of sampling plan; B. Illustration on the effect of the increase in frequency control on the probability of detecting contaminated batch/lot using Binomial distribution.

End product testing, such as the one used as the basis for HC issuance, is used to validate that a food safety assurance or food safety management system during the production of the exported nutmeg is in place. The result of the batch/lot testing is only one of the parameters needed for HC issuance, while the others are the assurance that the Good Agricultural Practices (GAP) and GMP, including hygiene and sanitation, are implemented along the nutmeg production chain. However, in the case of nutmeg export, the end product testing is useful in decreasing the risk of border rejection. In 2021, 496 HC applications were submitted to 6 (six) competent authorities, and 38 applications (5.8%) were turned down due to high level contamination with aflatoxin or ochratoxin A found during sampling (Table 3). Without the end product testing (HC), the border rejection will be higher than what was currently reported in RASFF windows portal. However, conforming the performance of sampling plan in Figure 2A, 9 (nine) out of 458 accepted lots were rejected at EU border points, indicating that the end product testing only is not sufficient measure to assure the safety of a nutmeg lot/batch.

Table 3. Health Certificate (HC) application and the rejected lot*

The number of HC application	The number of Rejected Application	% Rejection
496	38	5.8%
The number of HC Issued	The number of EU Border Rejection	% Rejection
458	9	2%

*based on 2021 HC application and EU border rejection.

3.3 Possible growth of *Aspergillus* spp. and toxin Production during shipment and storage

Some exporters also believe that the border rejection might be due to the growth of toxigenic *Aspergillus* spp. during shipment, which subsequently producing higher level of mycotoxin. Depending on the total volume, one or more nutmeg lots are usually shipped together in the same container, and to prevent condensation, cartons or paper kraft are used to cover the roof, walls, and floor of the container. Moreover, moisture absorbents (desiccant) are also placed in different parts inside the container. A check on the loading document showed that the temperature inside the container is 32°C with 51-52% of RH. The temperature inside a container can reach 50°C at sea and can drop to -29°C and as high as 57°C on land [10]. Temperature fluctuation during shipping can also trigger the container rain, a situation when moisture builds up in the container and rains down on the cargo. This situation could damage the cargo, by means of increasing the moisture content of dried nutmeg and making it vulnerable to the mold infestation. One of the exporters mentioned that certain parts of

cartons/paper craft were wet when the container was opened, indicating that possible condensation might occur during shipment. However, no information on the temperature inside the cargo nor temperature fluctuation during nutmeg shipment from Indonesia to EU was available to confirm this report. A report on wine shipment from Australia to USA during Summer (Australia) and Winter (USA) and during Winter (Australia) and Summer (USA) showed that the average minimum temperature at sea 11.76°C and at land 11.41°C (Australia) and 19.87°C (USA). Moreover, the average maximal temperatures were reported as 25.71, 21.32 and 25.15°C at sea, Australia and USA, respectively, although the maximal temperature can reach as high as 50, 42.50, and 38.50°C. On average, the temperatures during shipment, covering both sea and land legs, were recorded as 18.68, 14.50 and 22.04°C at sea, Australia land and USA land [11].

The moisture content of the nutmegs exported to EU were below 10% or corresponding to the water activity (aw) of <0.7. One of the rejected nutmeg consignments had in average moisture content of 7.34% or aw value of 0.57 when departing from Indonesian port. Since sufficient information on the correlation between the moisture content and aw of nutmeg is not available, a model derived from honey data and validated using areca nut data were used to estimate the aw of the nutmeg [12]. The data of areca nut is used since it has almost similar physical characteristic as nutmeg. Using this model, the moisture content of 10%, 12% and 14% is correlated to aw value of 0.68, 0.77 and 0.85, respectively. Further investigation on the correlation between moisture content of nutmeg and its water activity should be conducted to validate the value.

Studies on the growth parameters of *Aspergillus flavus* showed that this species has a minimum water activity (aw_{min}) of 0.68 – 0.81 in peppercorns [13], 0.83 – 0.85 in chili powder extract agar and paddy [14, 15], 0.78 – 0.84 [16] and 0.98 – 1 in growth medium [17]. The minimum temperature for growth (T_{min}) was reported at 11 – 16°C [13], 6 – 10 °C [18], 13°C [15], 8 – 10°C [17], and 10°C [19], and the maximum temperature for growth (T_{max}) was 42 – 43°C [13], 42°C [18], 46 – 47°C [15], and 48°C [18]. This reported variabilities in the cardinal growth parameter as function of temperature and water activity might be influenced by the use of difference strains, matrix, as well as different models used to estimate the parameters. Recent publication on the effect of storing temperature in suppressing *Aspergillus flavus* and mycotoxin reported that storing nutmeg at 16°C in hermetically sealed packaging result in the lowest observed colony diameter and mycotoxin production [20].

Considering that the exported nutmeg having less than the minimum aw required for initiating the growth, growth of *Aspergillus flavus* is unlikely, unless certain conditions permit them to grow and produce mycotoxin. However, growth of *Aspergillus flavus* was not in line with its toxin production. Yogendrarajah et al. [13] observed absence to very small production of mycotoxin, despite the heavy growth and sporulation of

the toxigenic strains used in their study. Even at optimum growth condition, both strains showed absence in aflatoxin production. Other study using brown and polished rice, however, reported the production of high-level aflatoxin at aw level between 0.90 and 0.92 at 20°C. However, due to the high uncertainty regarding to the mycotoxin production, it is important to prevent the growth of *Aspergillus* spp., which eventually minimize the risk of aflatoxin accumulation in food product, specifically nutmeg.

3.4 Strategies to minimize border rejection

To decrease the number of non-compliant consignment, and thus lowering the border rejection, government needs to set a target, for instance decreasing the number of border rejection by 70% in 5 years. Using the number of border rejection in 2022 and 2021 as the initial/baseline level, in 5 years the border rejection is allowed only 3 times for the whole year. Since the current prevalence of contaminated batch/lot is unknown, a hypothetical prevalence that 1 in 3 batches/lots (33%) is contaminated with aflatoxin B1 above EU limit is used as a baseline level. Using this assumption, the probability to find that 10 batches/lots are contaminated with aflatoxin B1 above EU limit is 15% (58% cumulative probability). When targeting only 3 batches/lots are found above the limit, then one should aim at the reduction of the prevalence to 1/30 (98% cumulative probability) or 1/40 (99% cumulative probability). The prevalence of 1/30 or 1/40 batches/lots corresponds to the prevalence of contamination 1% or 0.75% of the whole lots. The detail on the probability of finding batches contaminated with the mycotoxin above EU level, based on the prevalence of contamination as described previously, was illustrated in figure 3.

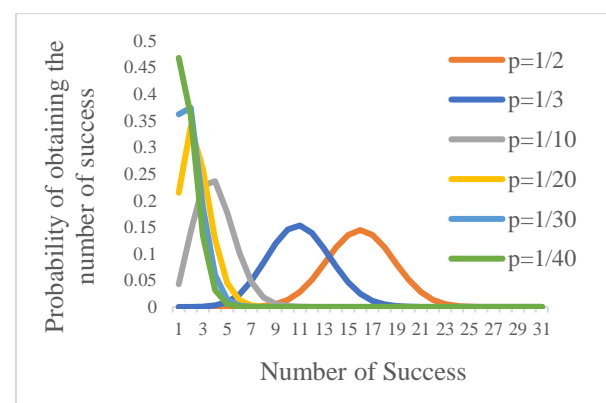


Figure 3. Probability detecting contaminated batch illustrated using Binomial distribution with different prevalence levels.

From the interviews conducted with the exporters having border rejection in 2021 and 2022, two possible sources of contamination were identified, which are raw material and possible growth during shipment (Table 4). When attribution has to be assigned for each source of contaminations, then the contribution from raw material is 80% (20 % each from XA, XC and XD and 10% each

from XB and XD) and possible growth during shipment is 20% (10% each from XB and XD). Although most of contamination comes from raw material, both sources of contamination will be considered to select for the most suitable option for the reduction of the prevalence of contamination.

Table 4. Possible sources of border rejection.

Exporter	Possible Source of Border Rejection
XA	Raw material (sourcing during wet season, moisture content 10-13%, no further drying step applied)
XB	Raw materials supplied from different regions, possible condensation during shipment
XC	Raw materials are sourced from new supplier
XD	Raw material and possible condensation
XE	Raw material (unshelled nutmeg supplied from previous year)

3.4.1 Controlling the raw material

Since there is no step which can fully eliminate aflatoxin or ochratoxin A when they are already present in nutmeg, obtaining high quality of raw material is of important. All of the interviewed exporters having border rejection in the period of 2021 – 2022 mentioned that they obtained the nutmegs from a new supplier, or it was obtained during a wet season and no further drying step was applied. To minimize of the risk of obtaining bad quality of raw materials, exporters usually sourced from supplier known to have a good quality or producing nutmeg following the GAP and GHP (Good Hygienic Practices). Some of them also invest in providing trainings to their supplier on how to produce a good quality nutmeg. However, when the demand was high and the supply was limited, they sometimes looked for nutmeg from a new supplier or new regions as an alternative.

Usually, the incoming material was tested for the moisture content and the presence of mycotoxin, either by sending the samples to external laboratory, internal laboratory, or using an aflatoxin test kit. An exporter mentioned that obtaining in-shelled nutmeg is less likely to be contaminated with *Aspergillus flavus* or aflatoxin. Even when these measures are applied, competent authorities still rejected 5.8% of application, due to high level of aflatoxin and ochratoxin A contamination. When the prevalence of high contamination level is set at 1% or 0.75% and assuming that the number of HC application is the same as the one in 2021, the rejection during HC application is allowed only for 5 or 4 batches/lots. Even at this low prevalence level, there is still 67% and 74% probabilities that the contaminated batch/lot is accepted during sampling.

To have this low prevalence level of contamination, the government or competent authority should require the exporter to obtain nutmeg from the supplier implementing good practices, such as GAP, GMP and

GHP, and that the incoming raw materials should be accompanied by the certificate of analysis, stating that the incoming batch having mycotoxin contamination less than what is required by EU regulation. In the case that the supplier sends the nutmegs without certificate analysis, it is the responsibility of the exporter to check the safety of the raw materials. It should be also mandatory that the raw material has aw level below 10%. The newly adopted Codex standard on nutmeg could be referred as a guidance when purchasing raw material from the supplier [21]. However, to prevent the growth during storage and shipment, the supplier shall request that there should be no visible mold observed, although the Codex standard allows this as much as 5% for inshell and whole shelled nutmegs.

The measure, that the exporters should obtain only high-quality raw material, should be made mandatory and the information on the quality and safety of the material should be supplied to the competent authority when the exporter applies for the health certificate. It should also be mandatory that the exporters have HACCP system implemented to have control on the critical steps, which are able to minimize the mould growth and toxin production.

3.4.2 Preventing growth of *Aspergillus* spp. during shipment

Contamination during shipment might occur when the shipment condition permits *Aspergillus* spp. to grow and subsequently produces mycotoxin. Growth might also occur during storage at exporter storage room since the exporter usually obtains the nutmeg gradually months before the shipment and kept them at the storage room, with or without controlled temperature and humidity. The moisture content of raw material, which is less than 10% ($aw < 0.7$), does not support the growth of *Aspergillus* spp., but the moisture content might increase during storage and shipment. However, small increase in water activity from 0.52 to 0.54 and 0.57 was reported in mixed spices held for 6 months at 27°C and 37°C, respectively [22]. The lowest reported minimum aw for *Aspergillus* spp. was 0.68 or corresponded to the moisture content of 10%. An exporter reported that the rejected lot of nutmeg contained raw material obtained during wet season, which has moisture content of 10 – 13%. The exporter did not subject these nutmegs to further drying process and were kept in the storage room having temperature between 24 and 26°C and RH between 79 – 82%. This condition might facilitate the growth of mold and toxin production. However, manual sorting and the use of UV light could minimize, although not totally removed, the risk of rejection due to the presence of high-level aflatoxin or ochratoxin A.

Moreover, to prevent or minimize the growth of *Aspergillus* spp. during shipment, two measures such as sterilization and the use of reefer container could be considered. Sterilization of nutmeg lot could be made mandatory to prevent growth/outgrowth during shipment, although sterilization cannot decontaminate pre-formed aflatoxin. However, the effect of

sterilization on the border rejection is inconclusive. Of the 319 batch/lot applying for HC at one of the competent authorities in 2021, 121 batch/lot were thermal sterilized and 198 did not have sterilization process. After the result of analysis, of 28 rejected applications, 4 batches/lots were thermal sterilized, indicating that sterilization cannot decontaminate pre-formed mycotoxin if it is already present in the batch/lot (Figure 4). The growth of *Aspergillus* spp. also less likely to occur during shipment, because the border rejected consignment was mostly caused by high level of mycotoxin and only 1 (one) caused by visible mold contamination. This fact indicating that the toxin might already been formed before shipment, either by the growth of *Aspergillus* spp. during storage or by the use of low quality of raw materials. If the growth occurs during shipment, more batches/lots will be rejected due to visible mold found during border check.

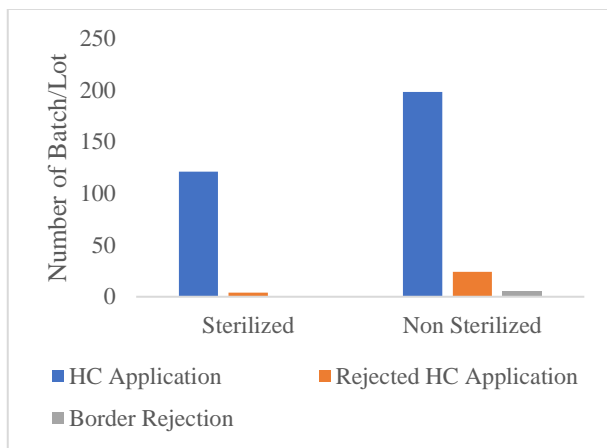


Figure 4. Number of batch and sterilization treatment.

The exporter experiencing 5 times of border rejection in the same year considered to use a reefer container to prevent the growth of *Aspergillus* spp. during shipment. However, temperature fluctuation was also reported in the reefer container used to transport fruits and wine, and therefore possible growth might occur if the temperature was above the minimum growth temperature of *Aspergillus* spp., which was reported as low as 6°C – 8°C in food products. Besides reported temperature fluctuation, the cost of a reefer container is also higher than the conventional one. However, comparison between the impact of shipment using conventional and reefer container on the border rejection cannot be made since all nutmegs were shipped using conventional container. Moreover, the fact that not all batches/lots loaded using the same container were rejected also indicated that it might be not the shipment in a conventional container nor the possible growth during shipment caused the border rejection.

3.4.3 The optimal strategy to minimize border rejection

The measures that the exporter should obtain high quality of raw material and implement HACCP to

control the critical steps, including raw material procurement, are deemed necessary to minimize the non-compliance, and thus border rejection. Raw material has 80% attribution of possible source of contamination, so controlling this source could give a minimum of 80% reduction to the current number of border rejection. In implementing this measure, the competent authority, who issues health certificate, should notify other authority having control at upstream stage. Therefore, the authority could provide support for the production of good quality of raw material, such as providing registration for the field implementing GAP and providing sufficient infrastructure for drying the nutmeg seed. The selected measures can be implemented gradually during 5 years, considering the readiness of the exporter and the whole nutmeg production support system, including farmer, collector and the competent authority.

4. Conclusion

The increase in EU frequency control of nutmeg shipment from Indonesia increases the likelihood of border rejection due to the presence of high level of mycotoxin contaminated samples. The assurance that the exported nutmeg having contamination less than EU legal limit cannot solely be relied on the result of the end product testing, such as the one use in health certificate issuance. The analysis on the performance of sampling plan showed that there is always probability that the contaminated samples go undetected, unless the whole batch/lot is tested. To decrease the number of non-compliance batch/lot, the competent authority needs to set a target for reducing the prevalence of high contamination level and implementing sufficient measures to achieve the target. The prevalence of high contamination level could be set as low as 1% or 0.75%, and for achieving the target, two possible measures are considered, controlling the raw material and preventing the growth of *Aspergillus* spp. during shipment. Of these two possible measures, raw material has the attribution of 80%, and therefore controlling raw material will be able to reduce the non-compliance by 80%. To control the raw material, the exporter is required to obtain a good quality raw material and implement HACCP. The selected measures shall be made mandatory and should be implemented gradually during 5 years, considering the readiness of the exporter and the whole nutmeg production support system.

Conflict of Interest

None to be declared.

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