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Report on Piloting a Low-Cost Portable Fish Drier & Food Safety Test Results of Powdered Dried Fish

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Implemented by:
DEPARTMENT OF FISHERIES MYANMAR
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Collaborating Household Feedback Report on Piloting a Low-Cost Portable Fish Drier

I. Background

Traditional fish drying practices in Myanmar typically leave product open to possible contamination by insects like flies and cockroaches, rodents including mice and rats, household dogs, cats and chickens and birds, with increased resultant food safety and human health risks. The likelihood of contamination is greater in the pre- and monsoon season, when there is less sun and the fish drying period is longer.

Pilot testing of a low-cost portable fish drier by 20 collaborating households in both Kale and Shwebo Townships, Sagaing Region and 20 households in Kengtung Township, Shan State was supported under the Myanmar Sustainable Aquaculture Programme (MYSAP) which is funded by the European Union (EU) and the German Federal Ministry for Economic Cooperation and Development (BMZ) and which is implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH and the Department of Fisheries.

WorldFish, which is realising MYSAP's inland component under a GIZ grant agreement, with Ar Yone Oo, BRAC Myanmar and Malteser International as sub-contracted implementing partners is advocating the production and consumption of small indigenous fish species, also called SIS, because when eaten whole, SIS are micro-nutrient rich. This is particularly important in Myanmar where 35%, 27% and 19% of children aged 6-59 months' of age are anaemic, stunted and under-weight respectively, and pregnant and lactating women and children (6-59 months) suffer multiple micro-nutrient deficiencies[1]. In addition, animals source foods (ASF) are not normally introduced as complementary foods for infants until typically 12 months' of age and this late introduction of ASF can delay both physical and cognitive development of infants with life-long consequences. This work was undertaken as part of the CGIAR Research Program on Fish Agri-Food Systems (FISH) led by WorldFish.

Moreover with the recent lockdown restrictions within Myanmar during the COVID-19 pandemic, the poorest, most vulnerable households are most at risk, making the consumption of a balanced and nutritionally diverse diet to boost the body's immune system even more important, as recommended by the World Health Organization[2].

The aim of the study was to produce food safe dried fish by subsistence households and to promote use of dried powdered SIS that can be added into rice porridge or noodle soup as a complementary food for infants over six months of age and in family foods for young children. Feedback from the 60 collaborating households that piloted the portable fish drier is summarized in this report, will be used to further improve the current drier design and to understand what encourages and hinders the usage of the pilot drier and this improved, but simple, applied technology.

The initial idea for the portable fish drier was inspired by a Thai design, which MYSAP Inland modified and tested as 2 prototype versions, before having 60 fish driers manufactured in Shwebo Township that were distributed to 20 households in each of three townships for community testing. To support the collaborative trial, MYSAP Inland with input from the WorldFish Myanmar nutrition

[1] The Myanmar Micronutrient and Food Consumption Survey 2017-2018.

[2] https://www.who.int/campaigns/connecting-the-world-to-combat-coronavirus/healthyathome/healthyathome---healthy-diet

advisor produced a handbook entitled *Pilot testing of a low-cost portable fish drier in the communities and Guide for preparing dried fish powder at home*, that details the protocol followed, which was also distributed to each of the participating trial households.

II. Participants

A total of 60 households, each with a child under five years of age were invited to join this pilot trial being 20 households from Kale Township and Shwebo Township, Sagaing Region and 20 households from Kengtung Township, Shan State from May to August in 2020, covering the pre-monsoon and the monsoon period.

The collaborating participants were selected based on the following criteria which were agreed with the partner NGO's in the field being Ar Yone Oo, BRAC Myanmar and Malteser International operating in Kale, Shwebo and Kengtung townships respectively:

1. The trial participants must meet one or more of the following criteria:
    a. An MYSAP Inland direct beneficiary household small-scale aquaculture (SSA) group member, who is a female head of the household;
    b. MYSAP Inland direct beneficiary household SSA group member, woman or man with a child under five years of age living at home;
    c. Local fish vendor within Kale, Shwebo or Kengtung townships;
    d. A local fish processor within Kale, Shwebo or Kengtung townships;
2. Must be willing to be 'researchers in process' who test out the fish drier for four months, and provide verbal feedback and recommendations for improvement either by telephone or in a face to face interviews to community facilitators and or MYSAP Inland staff.
3. Must be willing to follow the detailed activities, which were provided in an instruction manual in Myanmar language provided by MYSAP Inland.

The selected collaborators included 22 women and 38 men from the three townships and 24, 20, and 16 were Burman, Shan and Chin ethnicities respectively. All the selected households had a small-scale pond under 0.5 acres (2,023 m^2) in area, which held water for at least six months per year. The total pond area and fish production of the participating households ranged from 0.02 – 0.55 acres (0.008 - 0.22 ha) of fish ponds and from 6.2 – 980.5 viss of fish $acre^{-1}$ $year^{-1}$ (25.0 – 3,947.9 kg ha^{-1} $year^{-1}$) in the 2019-20 culture season.

A feedback questionnaire was designed and after pre-testing and modifying the questionnaire, data was collected and entered into the KoBo Toolbox digital platform by the field staff of Ar Yone Oo, and Malteser International staff during the last week of September 2020 and by the field staff of BRAC Myanmar during the last week of October 2020.

The process followed for the production of the dried small indigenous fish and grinding to produce a fish powder with no visible bones is illustrated as Annex 1 of this report.

III. Findings

1. Context

Since the target area of MYSAP Inland is full of diverse communities with various food consumption behaviours, the preferred methods of handling fish post-harvest, value chains, processing and preparing fish for consumption were also diverse. According to the respondents, fish drying was not a common process in either Kale or Shwebo townships, though six respondents from Kengtung thought Kengtung people usually dried fish. Additionally, while not all the interviewed households from Kale and Kengtung townships consumed dried fish, every respondent from Shwebo agreed that people in that township usually ate dried fish.

2. Production and Effectiveness

When asked about the relationship between MYSAP Inland and the direct beneficiary household and its family members, and MYSAP supported activities involved in testing the portable fish drier, only two respondents from Kengtung Township mentioned that they had not effectively used the fish drier during the collaborative trial period. The reasons given for not using the fish driers were heavy rainfall, and the inconvenience caused by the closed layers that limited air ventilation and direct exposure to the sun. One of the respondents had never dried fish before, even by traditional methods. However, a total of 50 respondents mentioned that they had used the fish drier with the frequency of use ranging between at least once and up to three times a month, while the other eight respondents said that they had used the drier at least four times a month. With fresh fish being the most popular form of fish sold, fish were normally only dried when there was excess fish harvest from a pond or catch from the wild that could not be sold the same day. The majority of people involved in this trial normally did not dry fish, so there was unfortunately no baseline dried fish production against which to compare using the pilot fish drier.

Table 01 below shows that the total amount of dried fish produced by the 58 collaborating households using the fish drier during the month was 126.6 viss (205.4 kg) with Shwebo Township having the highest dried fish production, with a total of 58.0 viss (94.5 kg). The fish drying processors from Shwebo produced between 2-6 viss (3.3-9.8 kg) of dried fish, while nine processors from Kale Township produced less than 1 viss (1.6 kg) of dried fish during the trial period. The mean dried production of the 58 collaborative trial households was 2.2 viss (3.6 kg) of dried fish. For each 1 viss (1.6 kg) of dried fish produced MYSAP Inland supplied approximately 4 viss (6.5 kg) of fresh fish as the raw material input for the collaborative trial.

Quantity produced for the month (viss)	Kale		Kengtung		Shwebo		Farmer #	Total Production (viss)
	Farmer #	Production (viss)	Farmer #	Production (viss)	Farmer #	Production (viss)		
<=1	10	5.4	9	8.7	0	0	19	**14.1**
2	4	8.0	5	9.5	9	18.0	18	**35.5**
3	5	15.0	3	9.0	6	18.0	14	**42.0**
4	0	0	1	4.0	2	8.0	3	**12.0**
5	0	0	0	0	1	5.0	1	**5.0**
6	1	6.0	0	0	2	12.0	3	**18.0**
Total	**20**	**34.4**	**18**	**31.2**	**20**	**61.0**	**58**	**126.6**

***Table 01**. Quantity of dried fish produced by the processors for the month (Viss)*

The key voiced concern of the respondents about the fish drier was a quality of its manufacture, with 19 of 60 respondents (31.7%) reporting that they thought the material and mesh used for fabrication of the fish drier was not of good quality. Only 2 of 60 selected households for the collaborative trial failed to use the fish drier at all and the reasons stated for this were inconvenience, low capacity of the drier and the perception that too much time would be required for too little benefit and poor-quality of the drier material.

Those respondents that did put the pilot portable fish drier to use during the collaborative trial provided feedback that it produced a safe high quality dried fish product because the drier was enclosed or sealed (93%), was easy to use with the zipper (93%), was pest and animal proof (90%), could easily be cleaned (83%), was light weight (73%), and was fabricated from good quality material (68%). The majority of respondents felt the fish drier was easy to use and clean.

19 processors out of 20 from Kengtung had previous experience of fish drying using traditional methods at home, while 1 of 20 respondents had not previous fish drying experience at all. Both Kale and Shwebo had 15 of 20 respondents from each township that had prior experience of fish drying using traditional fish drying methods.

Those respondents with previous traditional fish drying experience were all in agreement that the trial fish drier had advantages over the old practices. The most significant perceived advantages cited were that the trial drier kept flies, insects and animals away from the drying fish (96%), and that it was easy to move the fish drier from one location to another (94%) respectively, see (**Figure 01**).

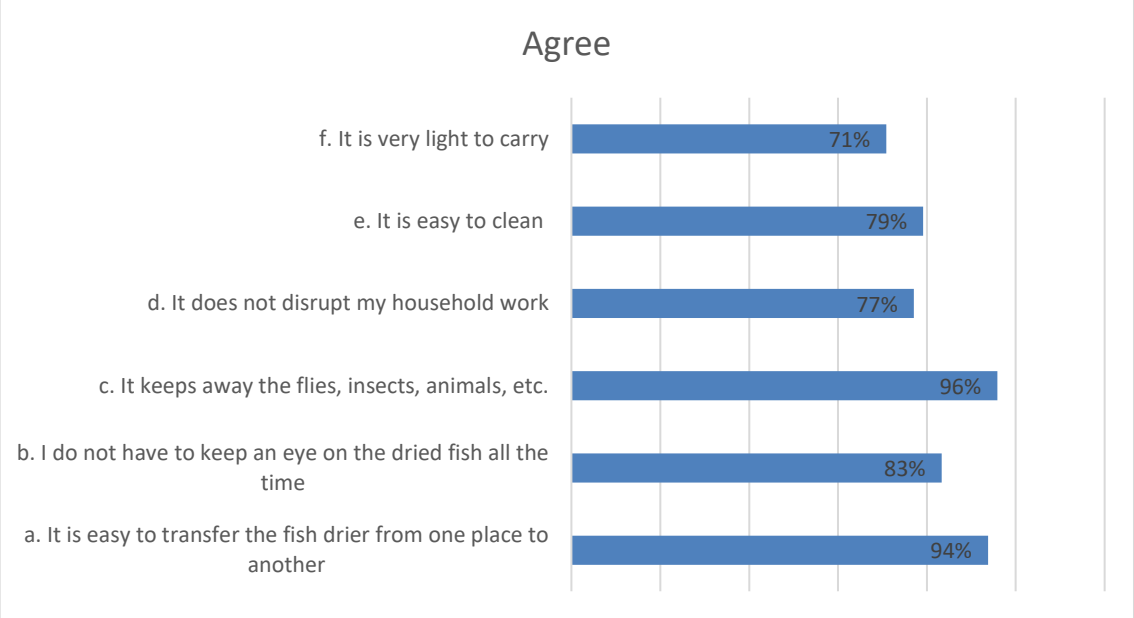

***Figure 01**. Advantages of the trial fish drier over traditional methods*

The respondent from Kengtung who mentioned that the capacity of fish drier was insufficient and who did not dry fish using traditional methods was the only respondent with a negative perception on using the trial drier to dry fish at home in the area. 56 of 58 of the participants that tested the pilot fish drier, felt that it was worth their time and effort to use the pilot drier.

The two main reasons for favouring the fish drier were that it might help to increase the supply of dried fish (79%) which household members liked to eat and it increased the shelf life of the dried fish product (77%) (**Figure 02**). While only 39% of participants perceived that the dried fish produced using the pilot fish drier was safer and of better quality dried, 96% of them agreed that the pilot fish drier prevented flies, insects and animals from contaminating the fish while it was drying (**Figure 01**).

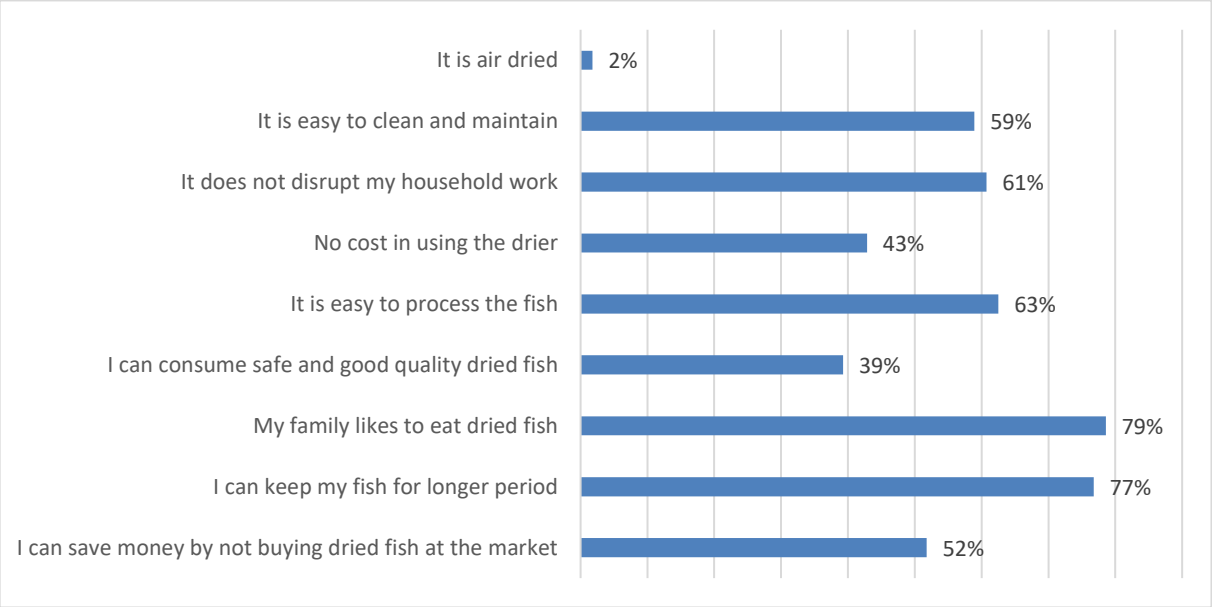

Figure 02. *Positive attributes of the fish drier*

3. Perceptions on the portable fish drier

While other respondents felt it was worth their time and effort to use the pilot drier for drying fish, there were four collaborating households that stated that using the portable fish drier was not worth their time and effort. One Kengtung Township respondent said that using the drier was time-consuming. Three respondents from Shwebo Township who produced only around 2 viss (3.3 kg) of dried fish product between 1-3 times, said that it was more convenient to buy dried fish from the local market rather than processing it themselves, and that the product bought from the market was of better quality.

Very few of the respondents identified any unintended negative consequences of using the pilot fish drier. One exception was a respondent from Kale Township who replied that their high work load at home restricted their use of the drier. Forty eight (80%) of 60 collaborating household participants had positive experiences of using the pilot fish drier and for 34 of those 48 positive respondents, a significant impact for them was that they would be able to feed their family with an animal protein source food at times of year when food would be scarce (34 of 48 participants) (**Table 02**).

Table 02. Positive consequences of using the pilot fish drier

Positive Consequences	Total participants
Earning additional income from selling the dried fish produced	7
Becoming a leader of my group which makes me happy	18
Gaining more friends because they see me doing different activities	22
Able to feed my family with animal source food during the time that there is less food	34
Gaining more confidence in making decisions at home	20
Using the drier in drying vegetables, etc. to extend the shelf-life of the food	20
Able to feed the baby fish powder	1
Able to provide my family with more nutrition	1

Table 02. Number of processors with their perspective on the fish drier

Portability was cited as being the most significant feature of the pilot drier by 97% of the participants. Other positive features in descending order were easiness of cleaning (82%), producing safe and high quality dried fish (80%), and ease of arranging the fish for drying (65%). The key design flaw reported by 57% of the respondents was stretching of the nylon netting, with holes forming after repeated use, and 47% of respondents saying that the pilot fish drier was too long. Seven respondents reported no negative features of the pilot drier.

Table 03 below lists some design issues and some quality issues identified by the collaborating households, with the quality issues being more of an issue with more frequent pilot drier use. If MYSAP addresses the issues cited below it would improve the quality of the portable drier to better suit their requirements of the collaborating households.

Worst Features	Type of issue	Number of mentions
It has holes after multiple usages	Design & Quality	34
The length of the drier is long	Design	28
Do not have any issue		7
Poor design	Design	3
Poor quality material	Quality	3
It is not easy to clean	Design	1
The last layer receives less sunlight	Design	1
Seam became wider and unsafe	Quality	1
It takes a longer time to dry	Design	1
The rope does not last long	Quality	1

Table 03. Worst features according to the respondents

4. Pricing of the fish drier

All of the respondents agreed that the price should be less than MMK 30,000 (€ 20) for local farmers, fish vendors and fish processors, if a factory was going to mass-produce the fish drier.

5. Food safety testing and proximate analysis

A total of 16 kg of dried powdered SIS samples taken from the 60 collaborating households were collected and couriered via Mandalay to the DoF Quality Control and Research Section (QCRS) Analytical Laboratory Yangon, where proximate analysis (measurement of moisture, crude protein, fat, ash and salt levels) and the following 20 different food safety parameters were tested for 20 pooled samples per township.

Total plate count; Coliforms; *Escherichia coli*; *Staphylococcus aureus*; *Salmonella*; *Vibrio cholerae*; *Listeria monocytogenes*; *Vibrio parahaemolyticus*; *Shigella*; *Enterobacteriaceae*; yeasts; moulds; aflatoxin B1; histamine; DDT; heptachlor; dieldrin, cadmium, mercury and lead. The test results are given at Annex 2 of this report.

IV. Discussion and conclusions

The key aim of piloting the portable fish drier was to reduce contamination and food safety risk of traditional fish drying methods. This was met, with 96% and 94% respectively of collaborating respondents stating that the drier prevented contamination of the drying fish products by insects and animals and that the drier was light and flexible enough to be portable.

Two positive nutritional benefits of using the portable drier were also highlighted by the collaborating households during this pilot by 34 of 48 respondents (**Table 02**) and 77% of respondents (**Figure 02**) respectively, namely that:

i) They were able to provide animal source foods at times of the year when food was scarce; and
ii) Fish could be kept longer or the shelf life of fish was extended.

Both the above benefits are particularly important for poor and vulnerable households that have suffered most from the COVID-19 pandemic and movement restrictions which have reduced employment opportunities and income.

While MYSAP Inland always wants to facilitate the involvement of women in its development activities, consideration has to be given to avoid imposing additional work on extremely hard working women who already multi-tasking. While one woman from Kale whose work load limited her use of the fish drier, there were no cited negative consequences of using the drier and 83% (**Figure 01**) of respondents said that using the portable drier did not require them to continually worry and watch over the drying fish, which was normally an issue.

Suggestions for improving the pilot drier quality were to use better quality netting and rope with which to suspend the drier. Several respondents recommended modifying the design of the fish drier by taking out the bottom rack which receives less sunlight and which will make the drier shorter and easier to handle. These recommendations will be considered and highlighted to further improve this simple and low-cost technology.

While the piloting of portable fish drier has demonstrated an effective way of reducing the contamination risk during fish drying and the production of food safe dried fish, further more sustained development effort will likely be required to motivate households to a) use the fish drier on a regular basis.

The proximate analysis of the dried SIS showed that the crude protein content was between 51.4-54.9%, the moisture content between 9.6 in Kale Township to 11.35% in Kengtung Township, while the salt content was relatively low ranging from 2.3% in Kale Township to 3.7% in Kengtung.

The food safety test results for all 20 food safety parameters tested were within food safe levels for the dried SIS product from Kale, Shwebo and Kengtung Townships and the dried powdered SIS could be fed to infants over 6 months of age mixed with rice soup and mashed up vegetables.

Thelma Tun-Thein, MS, RDN, IBCLC, RLC, Registered Dietitian/Nutritionist and International Board Certified Lactation Consultant stated that feeding the dried SIS powder "would be helpful for increasing protein, with the analysis showing that all items tested fall within the acceptable ranges….. I think this powder will be a wonderful nutrient and flavour enhancer. The salt content is also low so this complements our typically high sodium Myanmar diet."

Further promotion of the pilot fish drier and feeding the dried powdered SIS as a complementary food for infants from six months of age by MYSAP and other agencies in Myanmar will encourage household production of food safe dried fish, while extending the availability of dried hygienic food safe aquatic products for household consumption.

Annex 1. Dried small indigenous fish species (SIS) production process

1. Raw material - small indigenous fish species (SIS)

2. Preparation of the SIS by washing in clean water

3. Cleaned SIS laid on a drying rack inside the portable drier

4. SIS drying inside the portable drier with the zip fastened

5. Multi-function electric grinder used to grind the dried SIS

6. After 60 seconds the dried SIS is a fine powder with no visible bones

7. Dried fried powdered SIS stored in zip lock bags

8. Dried SIS increase micro-nutrients and vitamins in a family meal

Annex 2. Food safety test results and proximate analysis

Proximate analysis results of the dried powdered SIS:

Township	Moisture content (%)	Crude protein (%)	Fat (%)	Total ash (%)	Salt (%)
Kale	9.60	54.9	11.50	21.5	2.2
Shwebo	10.80	51.4	12.43	17.5	3.3
Kengtung	11.35	53.2	11.96	18.5	3.7

Township	Aflatoxin B1 result	Analytical method	Comment
Kale	1.62 µg kg^{-1}	Competitive enzyme immunoassay	Maximum allowable EU limit for Aflatoxin B1 is 20 µg kg^{-1}
Shwebo	Not detected i.e. less than 1.3 µg kg^{-1}	Competitive enzyme immunoassay	
Kengtung	Not detected i.e. less than 1.3 µg kg^{-1}	Competitive enzyme immunoassay	

No Aflatoxin B1 was detected in the samples submitted from Shwebo and Kengtung Townships, meaning that the Aflatoxin B1, if present was below the competitive enzyme immunoassay method limit of detection, i.e. it was less than 1.3 µg kg^{-1}. Aflatoxin B1 was detected in the dried fried powdered SIS sample from Kale Township at 1.62 µg kg^{-1}, but this level of Aflatoxin B1 is food-safe and well below the European Union allowed maximum level of 20 µg kg^{-1}.

Township	TPC cfu/g	Coliforms cfu/g	*E. coli* cfu/g	*Staphylococcus aureus* cfu/g	*Salmonella* 25 g	*Vibrio cholerae* 25 g
Kale	5.2×10^5	< 10	< 10	< 10	Not detected	Not detected
Shwebo	4.5×10^5	< 10	< 10	< 10	Not detected	Not detected
Kengtung	4.0×10^5	< 10	< 10	< 10	Not detected	Not detected

Allowed levels in products for export from Myanmar:

Total plate count = 5×10^5 to 10^7

Coliforms = 11 – 500 cfu/g

Escherichia coli = 11 – 500 cfu/g

Staphylococcus aureus = 103 cfu/g

Salmonella = not detected

Vibrio cholerae = not detected

Township	*Listeria monocytogenes* 25 g	*Vibrio parahaemolyticus* 25 g	*Shigella* 25 g	*Enterobacteriaceae* cfu/g	Yeasts cfu/g	Moulds cfu/g
Kale	Not detected	Not detected	Not detected	< 10	< 10	< 10
Shwebo	Not detected	Not detected	Not detected	< 10	< 10	< 10
Kengtung	Not detected	Not detected	Not detected	< 10	< 10	< 10

Allowed levels in products for export from Myanmar:

Listeria monocytogenes = not detected (reference ICMSF 2nd edition)

Vibrio parahaemolyticus = not detected (reference ICMSF 2nd edition)

Shigella = not detected (reference ICMSF 2nd edition)

Enterobacteriaceae = < 300 cfu/g (reference ICMSF 2nd edition)

Yeasts = 102 to 105 cfu/g (reference ICMSF 2nd edition)

Moulds = 102 to 105 cfu/g (reference ICMSF 2nd edition)

Township	Aflatoxin B1	Histamine (ppm)	Mercury (ppm)	Cadmium (ppm)	Lead (ppm)	Arsenic (ppm)
Kale	5.92 µg/kg	14.50	0.062	0.045	0.072	0.102
Shwebo	Not detected	11.48	0.051	0.063	0.054	0.095
Kengtung	Not detected	26.73	0.072	0.059	0.081	0.086

Allowed levels in products for export from Myanmar:

Aflatoxin B1 = 20 µg/kg in feed materials and 10 µg/kg in complete feeds (EU standard)

Histamine = EU standard 200 ppm; India standard 20 ppm

Mercury = 0.05 ppm – EU standard (In house method based on AOAC)

Cadmium = 2.0 ppm – EU standard (In house method based on AOAC)

Lead = 10 ppm – EU standard (In house method based on AOAC)

Arsenic = 0.1 ppm for rice for infants in the EU.

Township	DDT (µg/kg)	Dieldrin (µg/kg)	Heptachlor (µg/kg)
Kale	Not detected	Not detected	Not detected
Shwebo	Not detected	Not detected	Not detected
Kengtung	Not detected	Not detected	Not detected

Allowed levels in products for export from Myanmar:

DDT = 5,000 µg/kg (reference, DoF)

Dieldrin = 300 µg/kg (reference, DoF)

Heptachlor = 300 µg/kg (reference, DoF)