AEGEAN EXPORTERS' ASSOCIATIONS

TURKISH DRIED FRUITS: OCHRATOXIN-A REPORT

Aegean Exporters Associations, Izmir-Turkey

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TİM TURKISH EXPORTERS ASSEMBLY

INTRODUCTION

Turkey is among the prime producers and exporters of dried fruit and nuts in the world. Aegean Exporters' Associations (AEA) "Aegean Dried Fruits Exporters' Associations" represents the business at national and international levels, develops national strategies and carries out projects to support exportation of high quality and safe dried fruit, nuts and their products.

In this respect, AEA has developed a monitoring system for mycotoxins in dried fruit right after the notifications received. Every year, raw material lots are sampled randomly to find out the average contamination levels.

Additionally, anonymous results of private companies are collected either directly or through laboratories yearly to lead the sector at large. The system was put in place for pesticides (2010) and Ochratoxin A (2017) in dried grapes, in for aflatoxins (2012) and ochratoxin A (2017) in dried figs and sulphur (2017) and Ochratoxin A (2018) in dried apricots.

Additional available data is gathered for dried mulberries. The notifications received through RASFF system is regularly collected and evaluated by experts. The collected data is shared with national authorities as well as the EU and with importer associations as FRUCOM.

This report summarizes the current situation regards, OTA occurrence, and exports to and consumption in selected countries with the aim of providing reliable and updated scientific data for discussions on setting MLs for Ochratoxin A in dried fruit.

EXPORT, IMPORT AND CONSUMPTION

DRIED GRAPE

According to Trademap data, total volume of dried grapes imported to the European Union is 388 672 tons in 2019 and Turkey supplied 51% of this volume by 198 331 tons. The breakdown of exported dried grape per country, total and per capita consumption levels of dried grape are presented in Table 1.

Table 1. Dried grape exports of Turkey destined to EU and consumption (total and per capita) in 2018 and 2019 with a breakdown for major importer states (including UK).

Country	2018						2019					
	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2
United Kingdom	74 099	96 159	77	93 227	1,389	1,851	71 750	96 093	75	93 163	1,388	1,850
Germany	31 337	72 837	43	63 060	0,759	1,011	28 215	71 622	39	62 008	0,746	0,994
Netherlands	32 669	51 791	63	39 117	2,293	2,866	22 438	52 102	43	39 352	2,307	2,883
France	16 563	28 261	59	25 939	0,399	1,209	16 368	27 899	59	25 607	0,394	1,194
Italy	19 984	23 128	86	22 337	0,368	0,737	18 701	21 671	86	20 930	0,345	0,691
Poland	5 304	13 517	39	12 824	0,338	0,676	4 578	15 996	29	15 176	0,400	0,800
Belgium	9 760	18 274	53	9 055	0,789	1,051	6 303	16 047	39	7 951	0,693	0,923
Spain	8 215	15 991	51	15 015	0,322	0,429	7 948	16 047	50	15 068	0,323	0,431
Greece	1 689	5 871	29	9 144	0,869	1,159	1 855	5 814	32	9 055	0,861	1,148
Total EU	**222 343**						**198 331**					
Total Other	**59 646**						**45 478**					
Total	**281 989**						**243 809**					
EU Total Import		**405 502**						**388 672**				

Sources: INC & Trademap.

1 Total consumption expressed in Kg per person. Population data from United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1.

2 Based on the estimated percentage of population consuming the specific product.

DRIED FIG

Total fig fruit imported to the European Union as fresh or dried is 80 851 tons in 2019 (Trademap data). Turkey provides 56 % of this volume by 45 226 tons. The breakdown of the fig exportation to the EU is 65.6 % (29 650 tons) of dried figs and 34.4% (15 576 tons) of fresh figs.

Table 2 shows that the consumption data of the two data sets vary significantly for dried figs ranging between 0.047 and 0.885 kg per year (Table 2). Greece is a dried fig country so local consumption could elevate the consumption figures. However, the consumption figures are significantly different in the two datasets compared to dried grapes and dried apricots.

Table 2. Fig (dried and fresh) exports of Turkey destined to Europe and consumption (total and per capita) in 2018 and 2019 with a breakdown for major importer countries (including UK and Switzerland).

Country	2018 (dried fig)						2019 (dried fig + fresh fig)					
	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2
Germany	7 023	19 297	36	15 809	0,190	0,761	14 615	17 077	86	13 990	0,168	0,673
France	8 486	14 862	57	12 871	0,198	0,792	9 092	17 476	52	15 135	0,233	0,931
United Kingdom	2 807	7 003	40	6 617	0,099	0,394	4 688	7 496	63	7 083	0,106	0,422
Netherlands	1 534	6 285	24	2 580	0,151	0,605	3 420	4 168	82	1 711	0,100	0,401
Italy	2 637	4 394	60	5 272	0,087	0,348	3 021	5 237	58	6 283	0,104	0,415
Switzerland	1 572	3 323	47	3 297	0,387	0,773	2 189	3 590	61	3 562	0,418	0,835
Belgium	561	2 333	24	1 619	0,141	0,564	746	2 969	25	2 060	0,179	0,718
Poland	456	1 784	26	1 775	0,047	0,094	849	1 642	52	1 634	0,043	0,087
Greece	259	869	30	4 656	0,420	0,885	150	612	24	3 279	0,296	0,623
EU Total	**30 321**						**45 226**					
Other Total	**31 006**						**39 817**					
Total	**61 327**						**85 043**					
Total EU dried fig							**29 650**					
Total EU fresh fig							**15 576**					
EU Total Import (Dried+Fresh)		**77 213**						**80 851**				

Source; INC & Trademap.

1 Total consumption expressed in Kg per person. Population data from United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1.

2 Based on the estimated percentage of population consuming the specific product.

DRIED APRICOT

Trademap data put forth that the total imports of dried apricots is 46 052 tons in 2019 and Turkey supplies 75% of dried apricots with 34 393 tons. France, Germany and the United Kingdom were the top three importers. The consumption of dried apricots per capita in these countries sourced from 2 international databases range between 0.027 and 0.320 kg per year (Table 3).

Table 3. Dried apricot exports of Turkey destined to Europe and consumption (total and per capita) in 2018 and 2019 with a breakdown for major importer countries (including UK and Switzerland).

	2018						2019					
	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2	Turkey's Export (MT)	Total Import (MT)	Import From Turkey (%)	Consumption (MT)	Consumption per capita (kg/year)1	Estimated Cons. Per capita (kg/year)2
France	7 558	9 602	79	7 195	0,111	0,221	7 515	8 703	86	6 521	0,101	0,200
Germany	6 158	8 895	69	7 842	0,094	0,189	6 103	7 271	84	6 410	0,077	0,154
United Kingdom	5 603	6 950	81	6 491	0,097	0,293	5 120	7 592	67	7 091	0,106	0,320
Poland	2 552	3 178	80	2 973	0,078	0,157	2 328	2 719	86	2 544	0,067	0,134
Italy	1 567	2 358	66	1 933	0,032	0,128	1 430	2 007	71	1 645	0,027	0,109
Switzerland	715	1 291	55	1 161	0,136	0,272	816	1 220	67	1 097	0,129	0,257
Total EU	34 555						34 393					
Total Other	58 825						65 276					
Total	93 380						99 669					
EU Total Import		48 523						46 052				

Source; INC & Trademap.

1 Total consumption expressed in Kg per person. Population data from United Nations, Department of Economic and Social Affairs, Population Division (2019). World Population Prospects 2019, Online Edition. Rev. 1.

2 Based on the estimated percentage of population consuming the specific product.

RASFF NOTIFICATIONS FOR DRIED FRUIT OF TURKISH ORIGIN

The RASFF notifications received between 2017 and 2020 for non-compliance of dried grapes and dried figs (as of November 22) are presented in Tables 4-6. Dried grapes exported from Turkey in 2019 total to 198 331 tons. If every lot is calculated as 20 tons maximum, the total number of lots is roughly 9 917. In 2019, the control frequency was 5 % meaning that the minimum number of lots sampled and analyzed for compliance to OTA ML, is circa 1 984. Even if the actual figures are announced by EU authorities, 30 lots out of 1984 received notification for non-compliance. This shows that 1.51 % of the lots had OTA contamination exceeding 10 ppb. Similarly, in 2020 as of November 22, 2020, 170 327 tons of dried grapes are exported, and the number of notifications remained as two despite increase of control frequency from 5 to 10 %. As will be seen in other tables, the impact of OTA on trade may vary according to the yearly conditions.

DRIED GRAPE

Table 4. RASFF Notifications for OTA presence in dried grapes of Turkish origin.

OTA	2017		2018		2019		2020 *(as of 22.11.2020)*	
	No.of samples	%	No.of samples	%	No.of samples	%	No.of samples	%
10-15 ppb	1	12,5	8	23,5	3	10,0	0	0,0
15-20 ppb	5	62,5	10	29,4	8	26,7	1	50,0
>20 ppb	2	25,0	16	47,1	19	63,3	1	50,0
Total	8		34		30		2	
Min. (ppb)	14,40		11,70		12,40		16,70	
Max. (ppb)	22,94		73,16		180,00		40,50	

DRIED FIGS

Table 5. RASFF Notifications for OTA presence in dried figs of Turkish origin.

OTA	2017		2018		2019		2020 *(as of 22.11.2020)*	
	No.of samples	%	No.of samples	%	No.of samples	%	No.of samples	%
10-15 ppb	0	0.0	1	20.0	1	12.5	0	0.0
15-20 ppb	1	33..3	0	0.0	0	0.0	1	16.7
>20 ppb	2	66.7	4	80.0	7	87.5	5	83.3
Total	3		5		8		6	
Min. (ppb)	16.90		10.70		13.00		19.90	
Max. (ppb)	588.00		134.00		189.00		61.20	

There is no common ML set for OTA in dried figs at EU level. RASFF Notifications for OTA in dried figs coming mainly from Germany and Netherlands, having national MLs as 8 and 10 ppb, respectively.

DRIED APRICOTS

Table 6. RASFF Notifications for OTA presence in dried apricots of Turkish origin.

OTA	2018	
	No.of sample	%
10-15 ppb	0	0.0
15-20 ppb	0	0.0
>20 ppb	1	100.0
Total	1	
OTA ppb	21.00	

OTA incidence in dried apricots is reported recently.

YEARLY MONITORING OF OCHRATOXIN A OCCURENCE IN DRIED GRAPES, FIGS and APRICOTS

DRIED GRAPE

Mondani et al. (2020) report that the most relevant species involved in OTA production in grapes is *Aspergillus carbonarius* and that berry infection by *A. carbonarius* is enhanced by damage to the skin caused by abiotic and biotic factors. So, the grape skin can provide protection from growth of genera Aspergillus section Nigri, the Black Aspergilli.

The yearly conditions also affect and in years with high temperatures and low relative humidity decrease both the European grapevine moth and the OTA concentration significantly. Insect pests and diseases causing skin damage can affect and increase OTA contamination in grapes. The dried grape industry works hard to clean the parties prior to marketing however there is no direct tool.

In case of dried grapes, the sorting machines can separate darker coloured or mouldy resulting in a reduction of OTA in packaged grapes (Figure 3). Despite this, there is a risk in some years not only due to elevation of moth damage but also regarding cracks/skin damage by abiotic stress. Even if the contribution of dried vine fruit to OTA intake is relatively low, lowering the maximum limits for OTA in dried vine fruits from 10 to 8 ppb, will cause problems especially in years of adverse conditions as 2018 since there will 5.1 % reduction, 11 118 tons of dried grapes will not be entering to the EU causing a trade loss of 16 644 000 Euros only with Turkey as the major producer and exporter. The reflection of this trade reduction means that nearly 2 224 Turkish farmers possessing ca 1 ha of vineyard will not be able to market their dried grapes. The economic loss occurring on both the exporter and importer side is around 16,644 million Euros.

Table 7. OTA incidence in samples collected from unprocessed raw material lots

Dried grape (Raw matter)						
Year	**Number of samples**	**Samples: ND (%)**	**Samples: OTA positive (%)**	**OTA Range(ppb)**	**Percentage of samples <8 ppb (%)**	**Percentage of samples <10 ppb (%)**
2017	10	20,0	80,0	0,40-40,0	76,9	76,9
2018	98	32,7	67,3	0,40-68,27	77,6	82,7
2019	225	53,8	46,2	0,21-37,87	91,6	92,9
2020	184	69,0	31,0	0,13-93,46	96,7	97,8

Table 8. OTA incidence in samples collected from processed dried grape lots

Dried grape (processed)						
Year	**Total No.of samples**	**No.of samples not detected (%)**	**No.of samples with OTA (%)**	**Concentration Range OTA (µg/kg)**	**No.of samples <8 ppb (%)**	**No.of samples <10 ppb (%)**
2017	906	48,3	51,7	0,20 - 88,83	97.6	98.6
2018	1206	39,5	60,5	0,07 - 55,49	98.3	98.9
2019	1836	53,9	46,1	0,01 - 200,51	98.2	98.6
2020	1130	71,2	28,6	0,18 - 1762,00	98.7	98.8

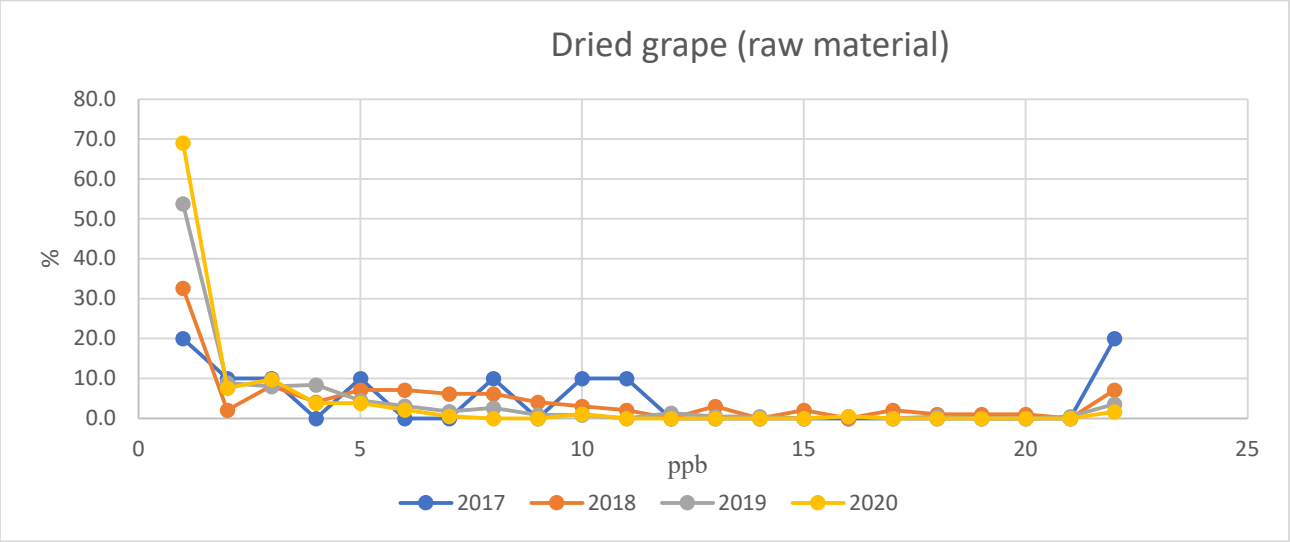

Figure 1. Distribution of OTA concentration among dried grape raw material samples collected between 2017 and 2020.

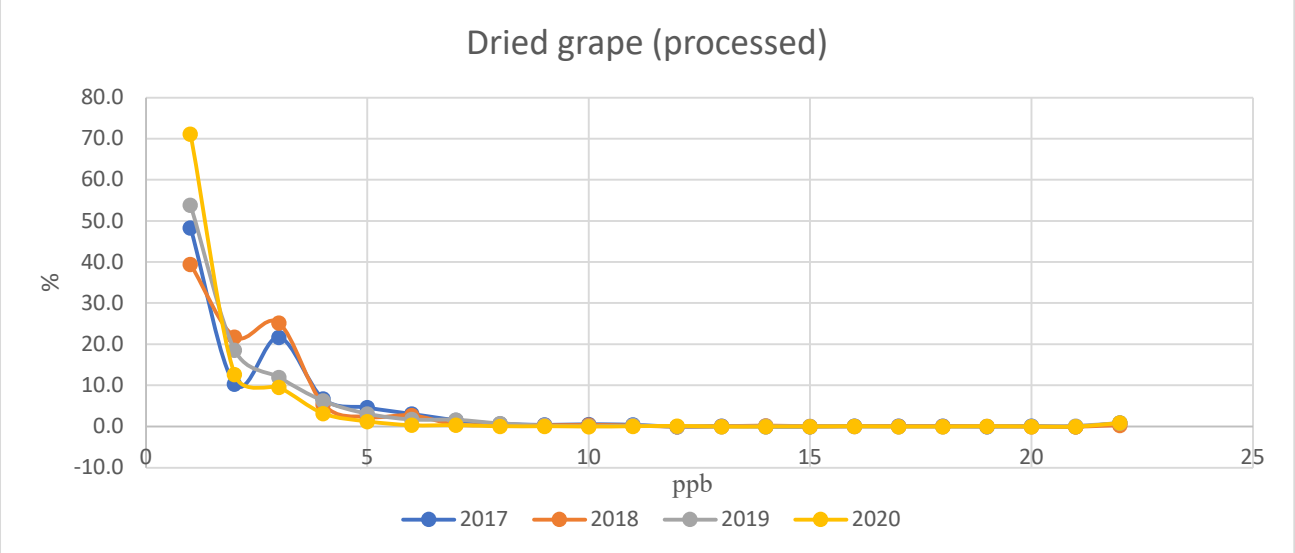

Figure 2. Distribution of OTA concentration among dried grape processed samples collected between 2017 and 2020.

In the overall comparison of dried grape samples taken from raw material entering into the processing facility and those collected from processed products show that sorting and removal of mouldy and dark coloured berries can reduce the number of OTA contaminated samples more effectively in some years e.g. 2017 whereas the effect on OTA contamination frequency was either none e.g. 2019 or quite low as in 2018 and 2020 confirming the findings of Mondani et al. (2020).

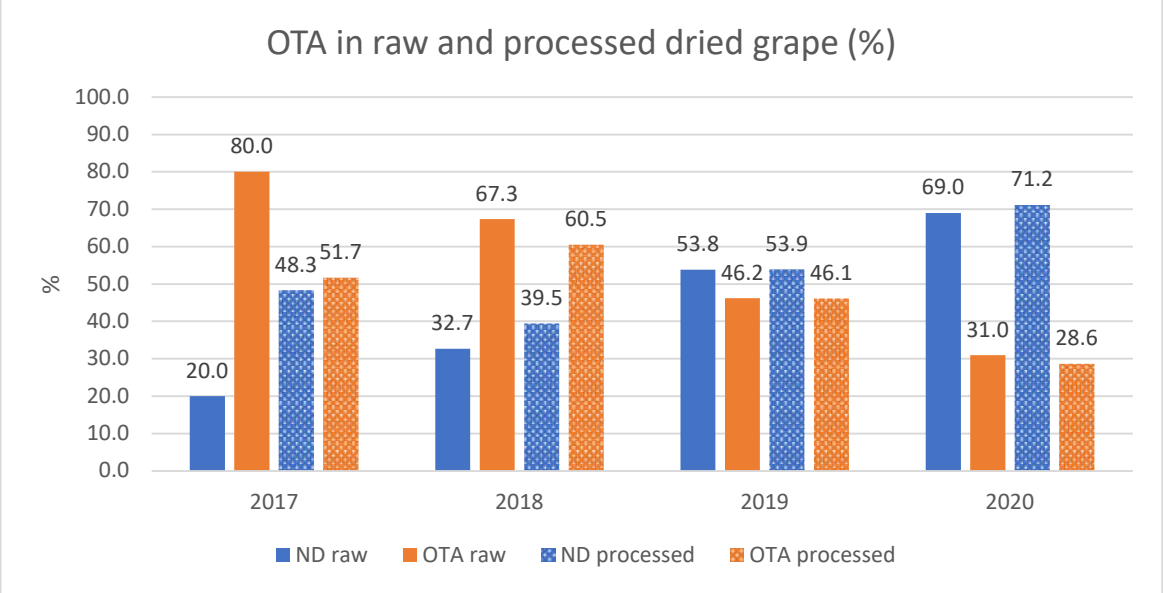

Figure 3. The percentage of samples found to have no OTA contamination (not detected) or contaminated with OTA above the limit of detection (LOD).

DRIED FIG

Each dried fruit with its morphology, physiology and composition display a different case. Contrary to the grape, the thick and fleshy skin of the fig fruit can not act as a barrier to toxigenic mould growth as in grapes. Furthermore, both the fleshy skin and especially the fruit cavity may provide suitable conditions for mould growth and OTA formation. Ochratoxigenic fungi are saprophytic and wind or dust may help for dispersal and land on the fleshy skin of the fig fruit. However, the transfer of the ochratoxigenic fungi into the fruit cavity is only through vectors as the fig wasp (*Blastophaga psenes* L.) that help pollination or through dried fruit beetles. Aspergillus section Nigri members isolated from dried figs is able to grow and produce OTA in a wide range of temperature (15–40^{0}C). *A. carbonarius* isolates produced OTA at all temperatures where growth was observed (Mutlu-Ingok and Karbancıoğlu-Güler, 2014). When mould growth occurs inside the hollow cavity, it is not possible to detect it during post-harvest or processing stages by any means. Various projects were carried out for removing dried figs especially having black mould growth inside the fruit cavity but were not very successful (Ortaç et al. 2015; Durmuş et al. 2015) .

Table 9. OTA incidence in samples collected from unprocessed dried fig lots

Dried fig (Raw material)						
Year	Total number of lots sampled	Number of OTA Positive samples (%)	Range of OTA contamination (ppb)	Number of samples		
				<8 ppb (%)	<10 ppb (%)	<15 ppb (%)
2017	56	39.3	0.67 - 233.4	92.9	92.9	92.9
2018	76	11.8	3.26 - 94.69	90.8	90.8	94.7
2019	50	34.0	1.75 - 430.88	74.0	76.0	80.0
2020	185	49.2	0.2 - 111.75	91.9	95.1	96.8

Table 10. OTA incidence in samples collected from processed dried fig lots

Dried fig (Processed)							
Year	Total Number of samples	Samples not detected (below LOD) (%)	OTA Positive (%)	OTA Range (ppb)	Percentage of samples exceeding thresholds (including not dedected)		
					<8 ppb (%)	<10 ppb (%)	<15 ppb (%)
2017	93	62,7	37,6	0,2 - 17,12	85,7	85,7	97,1
2018	478	70,5	29,5	0,35 - 15,89	98,2	98,7	99,1
2019	780	90,0	10,0	0,15 - 280,46	98,5	99,1	99,4
2020	968	48,2	51,8	0,3 - 1017,08	64,6	65,4	97,3

The evaluation of OTA positive (above LOD) samples processed according to the thresholds of 8, 10 or 15 show that the impact may vary according to the years. In 2020, the number of lots lying between 8 and 10 ppb comprise 1.1% of the total number of samples; Similarly the difference between 8 and 15 ppb in 2020 will include 32.7 % of the samples. In 2017, this ratio is calculated as 11.4; and 0.9 in 2018 and 2019. If the limit is set at 8 ppb, the impact economic impact on trade in Europe will be circa 33 737 000 Euro. The reflection back in Turkey will be limiting the access of circa 7 999 fig growers possessing average of 0.5 ha orchards. In case the limit is set at 8 ppb, it will create a loss of 4 % in 2018, 6% in 2019 and 4.9 % in 2020 when compared to 10 ppb. The evaluation should base on long-term yearly data rather than on composite data.

Dried figs, in addition to the difficulty in identifying and removing the contaminated figs (Figure 6), OTA has a skewed distribution (Figure 4 and 5) in dried figs and few fruits may have high OTA concentrations (Figure 4). In this respect, taken into consideration dried fig into consideration high measurement uncertainty in OTA analysis, the large fruit size may result in high variability under highly skewed distribution and lower maximum limits resulting in false large numbers of positives/false negatives.

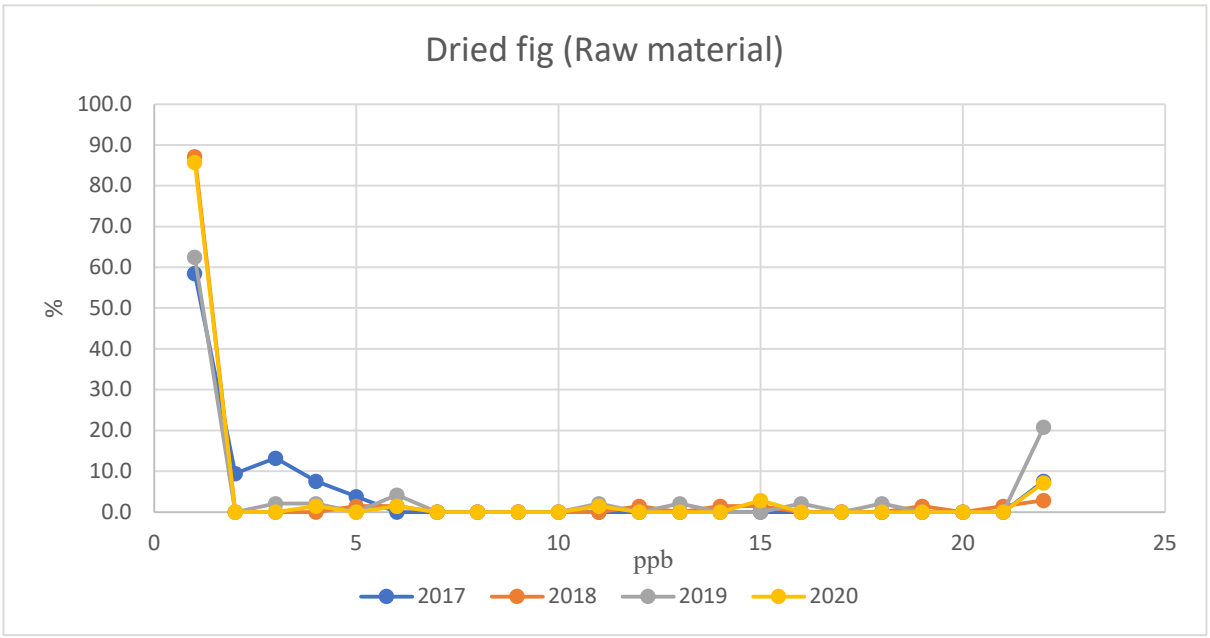

Figure 4. Distribution of OTA (ppb) among sampled lots between 2017 and 2020.

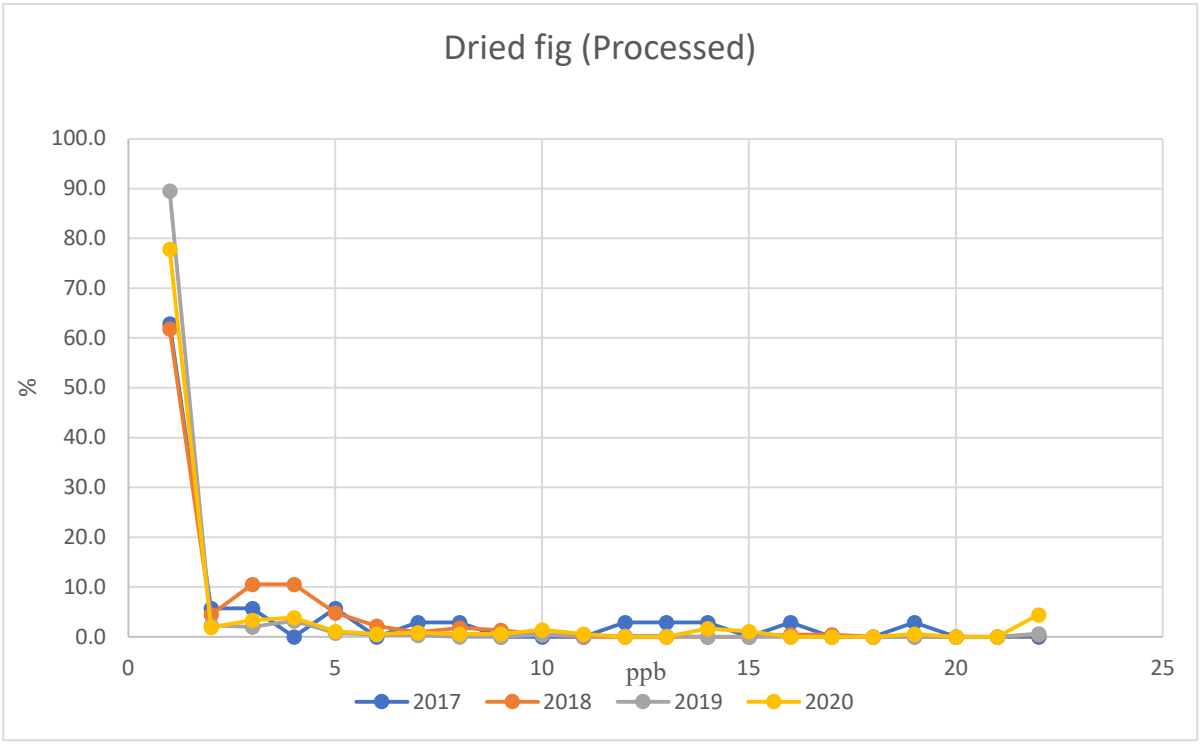

Figure 5. Distribution of OTA (ppb) among sampled lots between 2017 and 2020.

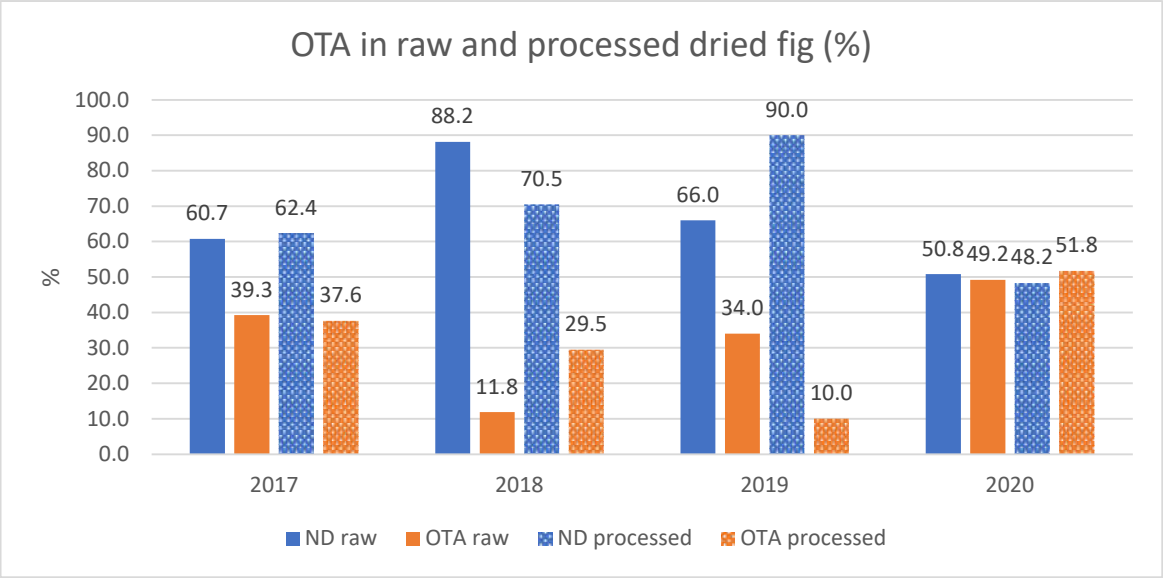

Figure 6. The percentage of samples found to have no OTA contamination (not detected) or contaminated with OTA above the limit of detection (LOD).

DRIED APRICOT

OTA monitoring started after the RASFF notifications were issued. At the beginning OTA was assumed to occur only in dried apricots that are not treated with sulphur. However, analysis of collected samples showed that OTA could be present in sulphured and dried apricots. Among dried apricot samples, 50 % pof the raw samples and 13 % of the processed apricots are sulfured and the rest are untreated with sulphur. OTA concentration of one sulphur treated dried apricot was measured as 8.9 ppb. Thus, further researchwork and data are required prior to setting up any limits for OTA presence in dried apricots.

Table 11. OTA incidence in samples collected from processed dried apricot lots

Dried apricots (Raw material)						
Year	**Number of samples**	**Samples: ND (%)**	**Samples: OTA above LOD (%)**	**OTA Range (ppb)**	**Samples below <2 ppb (%)**	**Samples below <10 ppb (%)**
2017	2	100	0	ND	100	100
2018	3	66,7	33,3	1,90	100	100
2019	3	100	0	ND	100	100
2020	2	100	0	ND	100	100

Table 12. OTA incidence in samples collected from processed dried apricot lots

Dried Apricot (Processed)						
Year	**Number of samples**	**Samples ND (%)**	**OTA Positive samples (%)**	**OTA Range (ppb)**	**Number of samples <2 ppb (%)**	**Number of samples <10 ppb (%)**
2017	1	99	1,0	0,90	100	100
2018	18	44,4	55,6	0,14 - 1,17	100	100
2019	57	93	7,0	0,47 - 2,71	98,2	100
2020	103	91,3	9,7	0,41 - 8,90	96,1	100

CONCLUSION

As presented above, the data collected for long-term and included in the report (between 2017 and 2020), support that the three targeted dried fruit even if they are important for trade, have different peculiarities. The yearly conditions both directly e.g. conditions favouring or suppressing prevalence of ochratoxigenic fungi or indirectly e.g. insect damage in dried grapes or vectors in dried fig exert significant effect on the incidence and concentrations.

The consumption of dried fruit is very low and thus its contribution to OTA exposure of the European population is much less than the processed meat, cheese or raw pasta as stated in the EFSA Opinion. These three crops come from perennial trees and thus monitoring on-site and annually puts forth a more realistic picture. Food safety is a priority for AEA and through the monitoring programmes, AEA has previously contributed to the database of the EU and of the Turkish Ministry of Agriculture and Forestry while making the risk assessment studies. AEA requests that the above points derived from thousands of precise, yearly and reliable data shall be considered in setting MLs for dried grapes, figs and apricots In order not to exert negative effects on trade while protecting the consumer.

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