Analysis Report of "Surveillance on Heavy Metal Contents in Edible Fats and Oils on the Market"

Summary

1. In order to understand the safety of edible fats and oils commercially available in the market, the Municipal Affairs Bureau (IAM) carried out a targeted food surveillance[1] in the fourth quarter of 2022, during which **a total of 150 samples of edible fats and oils were randomly collected** from stores in shopping malls, supermarkets and shopping intermediaries in Macao **to test for their heavy metal contents. The results revealed no abnormality, with a 100% pass rate.** It shows that the edible fats and oils commercially available in Macao are safe for consumption. The surveillance helps to get a picture of the contents of lead and total arsenic present in edible fats and oils sold in the local market, as a means to ensure the dietary health of the public.

Background information

2. A wide variety of edible fats and oils are sold in Macao and they are **generally classified into edible vegetable fats and oils and edible animal fats and oils**[2], based on their sources (Table 1). The public may choose the type of edible fats and oils that is most suitable for their culinary practices and food ingredients so as to enhance the aroma and taste of food.

Table 1. Common types of edible fats and oils sold in Macao

Edible fats and oils	Edible vegetable fats and oils	Edible animal fats and oils
Definition	They are edible fats and oils* derived from **edible plants**.	They are derived from **animals intended for human consumption that are in good health at the time of slaughter**.
Examples	Corn oil, peanut oil, rapeseed oil, sunflower seed oil, olive oil,	Butter, lard, goose fat, duck fat, etc.

	mustard oil, rice bran oil, grapeseed oil, sesame oil, palm oil, coconut oil, avocado oil, margarine, walnut oil, etc.	

*The products may be derived from a single plant source or are sold as blended oils that are generally designated as edible and used for cooking, frying, dining or salad.

3. Furthermore, the fatty acids in edible fats and oils **can be classified into saturated fatty acids and unsaturated fatty acids, based on their degree of saturation** (Table 2). In general, edible animal fats and oils tend to have a higher content of saturated fatty acids, while edible vegetable fats and oils have a higher content of unsaturated fatty acids. Trans fatty acids are a type of unsaturated fatty acid primarily used for enhancing the stability of edible vegetable fats and oils, and converting them from a liquid to a semi-solid state. However, the downside is that trans fats[3-5] can be formed during the process.

Table 2. Fatty acids in edible fats and oils

Fatty acids	Saturated fatty acids	Unsaturated fatty acids	Artificial trans fatty acids*
State	They are mostly **solid** at room temperature.	They are mostly **liquid** at room temperature.	They are mostly **semi-solid** at room temperature.
Properties	They are **more stable than unsaturated fatty acids at** high-temperature cooking, but are prone to conversion into cholesterol, which can lead to hyperlipidaemia,	They are **less stable compared to saturated fatty acids and are not suitable for high-temperature cooking**, but are beneficial to the control of blood lipids and may reduce the	Trans fatty acids may increase the levels of total cholesterol and of LDL (low-density lipoprotein) cholesterol in the blood, while decreasing the levels of HDL (high-density

	and **increases the risk of developing cardiovascular diseases.**	incidence of cardiovascular diseases.	lipoprotein) cholesterol. **This may increase the risk of developing cardiovascular diseases.**

*Edible vegetable fats and oils undergo hydrogenation to improve their stability, during which they are converted into a semi-solid state. The refining of fats and oils and using them repeatedly for frying or deep-frying may lead to the production of trans fatty acids.

4. Edible fats and oils are frequently consumed by the public, yet the **raw materials used in their production may have trace amounts of lead and total arsenic[6-12] accumulated in them through natural processes and industrial activities. Although crops and animal-derived food products undergo multiple processing stages, the finished products may still carry risk of contamination by heavy metals[13,14]** (for details, refer to Point 1) and 2) of Supplementary Document). Considering that the heavy metal contents in vegetable oils, edible vegetable fats and oils, and in edible animal fats and oils are important indicators of the safety of edible fats and oils and healthiness of the general public, it is necessary to monitor the contents of lead and total arsenic in edible fats and oils on a regular basis to reduce the consumption risks posed by related food products. In this regard, IAM carries out targeted food surveillances on heavy metal contents in edible fats and oils on the market to assess the safety of edible fats and oils sold in Macao.

Regulatory measures in Macao

5. Macao's **Administrative Regulation No. 23/2018 "Maximum Limits of Heavy Metal Contaminants in Food"** establishes the maximum levels of lead and total arsenic present in edible fats and oils[15] (refer to Table 3).

Table 3. Standards of test items in the surveillance on heavy metal contents in edible fats and oils on the market (extracted from Administrative

Regulation No. 23/2018 "Maximum Limits of Heavy Metal Contaminants in Food")

Heavy metal	Types of food	Maximum limits (mg/kg)
Lead	Edible fats and oils	0.1
Total arsenic	Edible fats and oils	0.1

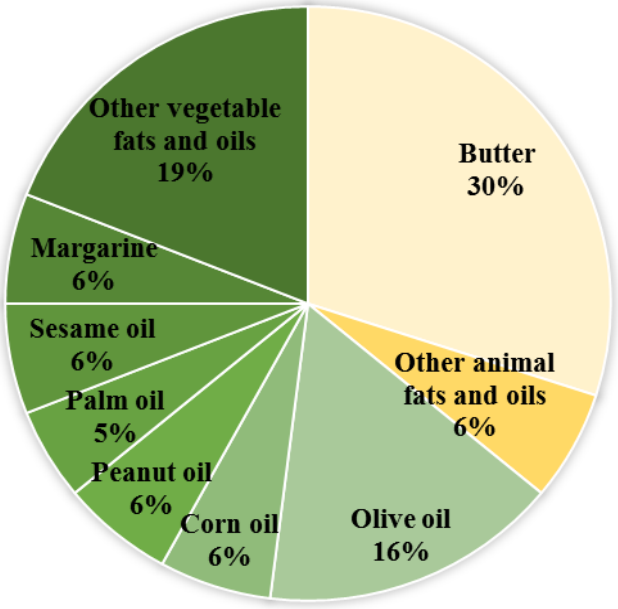
Purpose

6. The purpose of this surveillance is to understand the contents of lead and total arsenic present in commercially available edible fats and oils as a means to ensure the edible oils and fats sold in the market of Macao comply with food safety requirements.

Samples and items of testing

7. This targeted food surveillance was carried out by the Municipal Affairs Bureau (IAM) in the fourth quarter of 2022. A total of 150 samples (Figure 1) were randomly collected from stores in shopping malls and supermarkets across Macao. The collected samples included olive oil, corn oil, peanut oil, sesame oil, margarine and butter, among others, which were tested for the presence of lead and total arsenic. The countries and regions of origin of these samples included Mainland China, Hong Kong, Taiwan region, Japan, France, Italy, Portugal, the United States, Australia, etc.

Figure 1. Proportion of samples collected for the targeted food surveillance on edible fats and oils on the market



Conclusion and recommendations

8. The test results reveal that the **contents of lead and total arsenic in all samples of edible fats and oils comply with the requirements** established in Administrative Regulation No. 23/2018 "Maximum Limits of Heavy Metal Contaminants in Food" (Table 4), **with a pass rate of 100%**.

Table 4. Results of targeted food surveillance on edible fats and oils on the market

Edible fats and oils	Number of samples	Number of samples with heavy metal contents exceeding the standards of Macao	Lead (pass rate*)	Total arsenic (pass rate)
Vegetable fats and oils	100	0	100%	100%
Animal fats and oils	50	0	100%	100%

*The "pass rates" represent the fact that the contents of lead and total arsenic present in all tested

samples were within the maximum limits established for relevant food products in Administrative Regulation No. 23/2018 "Maximum Limits of Heavy Metal Contaminants in Food".

9. The surveillance helps to determine the contents of lead and total arsenic in edible fats and oils in Macao, and it provides a scientific basis for launching related work in the future. In addition, IAM has issued a press release to inform the sector and the public about the results of the relevant targeted food surveillance, and **the results have been uploaded to the website of "Food Safety Information"[1].**

10. Moreover, there are various channels for sale of food products in Macao, so the public do not only buy edible fats and oils from shopping malls, supermarkets and shopping intermediaries, but also shop online through social networking sites, instant messaging applications and other online channels. However, when purchasing food products from abroad through online stores and intermediaries, it is difficult to know whether the production, storage and transport of the overseas food products comply with food safety and hygiene requirements. Thus, it is advisable to avoid buying food products through the aforesaid sales channels.

11. In addition, edible fats and oils are high in fat and calories. The public is advised to use or consume them in moderation and maintain a balanced diet. They should also carefully read the nutrition label on the packaging of edible fats and oils before purchase.

12. **Advice to the sector and the public:**

Advice to the sector	Advice to the public
● Buy good quality edible fats and oils complying with hygiene standards from reputable suppliers; ● **Store the edible fats and**	● Always buy from reputable shops in good hygiene condition; ● Read the label on the packaging of edible fats and oils carefully when purchasing them. Never buy those

oils according to the storage instructions on their packaging. For those that can be stored at room temperature, keep them in a cool and well-ventilated place. For those that are more prone to spoilage, store them properly in the refrigerator (at below 5°C); ● In case of doubt about the source, hygiene condition and quality of food products, do not buy, sell or supply such products; ● The sector is obligated to **retain records of the purchase and sale of food products or the relevant receipts** to assist the competent authorities in tracing the source and distribution of food products as necessary, and to protect their own interests; ● For edible fats and oils that require refrigeration, like butter and margarine, always pay attention to temperature control during their storage, transportation and display. IAM has compiled the "Guidelines on Use of Refrigeration and Freezing Equipment" (GL 001 DSA 2022) [16] and the "Hygiene	of unknown sources or with labels containing ambiguous information; ● Read the label on the packaging of edible fats and oils carefully when purchasing them. Never buy those of unknown sources or with labels containing ambiguous information; ● **Buy the quantity needed for everyday use as far as possible.** For instance, buy edible fats and oils in small packaging size to ensure their freshness. For those in large packaging, divide the edible fat or oil into smaller portions with small bottles and consume them as soon as possible to prevent oxidative deterioration over time; ● After purchase, store the edible fats and oils in a cool and well-ventilated place away from sources of high heat (e.g. stoves) and avoid exposing them to sunlight, as this will accelerate their oxidative deterioration; ● If the edible fat or oil becomes discoloured or has an unusual smell (rancid or foul smell), do not buy or consume it; ● After opening, keep the bottle of edible fat or oil tightly capped or sealed. Avoid mixing old and new oils; ● Each type of **edible fat and oil has a different smoke point**[4] (refer to Point 3) of Supplementary Document) and culinary use. It is advisable to use the type of edible

Guidelines on Food Transportation" (GL 012 DSA 2015) [17] for the reference of the sector; ● Furthermore, IAM has compiled the "Guidelines on Use of Deep-frying Oils" (GL 007 DSA 2016) [18] to remind the sector of the food safety and hygiene practices required in using deep-frying oils.	fat or oil that best suits your cooking method.

Note:

In general, the more samples of edible fats and oils that are tested, the more helpful it is for understanding the safety of commercially available edible fats and oils. As this surveillance only collected and tested the samples of some of the most common edible fats and oils on the market, the results can only reveal the contents of lead and total arsenic in edible fats and oils sold in Macao in a given period.

Supplementary Document:

1. The following are the common processing methods for edible fats and oils (Table 4).

Table 4. Processing of edible fats and oils

Edible fats and oils	Common processing methods
Edible vegetable fats and oils	Crude oil* is extracted from the raw materials through **physical means (e.g. pressing), chemical means (e.g. extraction by solvents) or a combination of both methods.** Most crude oils are further processed to achieve the desired quality and properties. Undesirable and harmful substances present in the raw materials are removed during processing.
Edible animal fats	Animal fats are extracted **from fatty parts of animals by melting them in hot water or steam.** The melted fat rises to the surface of the water and is skimmed off, while unwanted meat

and oils	tissues settled to the bottom of the water.

*Before extracting oil from plants, defective raw plant materials must firstly be removed. Subsequently, the suitable materials are cracked and ground, and oil is extracted from them by pressing and/or with non-toxic solvents (such as hexane).

2. The following provides information on the application of lead and total arsenic, sources of these heavy metals as pollutants/contaminants, and their adverse effects on health (Table 5.1 and Table 5.2).

Table 5.1 Application of lead, source of lead pollution/contamination and adverse effects of lead on health

Heavy metal	Lead
Application	● Lead is widely used in the production of batteries, paints, metallic products and in other industries. ● Common sources of lead found in everyday life include lead-based paints, lead pipes, water heaters, lead-containing toys, crystal glasses, and the glaze coating applied to the surface of pottery, among others.
Source of pollution/contamination	● Lead **pollutes the air, soil, water sources and other natural resources** through various pathways. It accumulates in the food chain as contaminant and poses a risk to human health.
Adverse effects on health	● Currently, there is no level of lead exposure known to be safe. Overexposure to lead over a short time period may cause abdominal pain, vomiting, etc., while overexposure over an extended period of time can negatively affect development of the nervous system, result in anemia and hypertension, cause damage to the digestive system, impaired kidney function and impaired fertility. ● Excessive exposure to lead in children can

	affect their cognitive abilities and delay their intellectual development. In fetuses and infants, it may damage their central nervous system, whereas in pregnant women, it may result in miscarriage, stillbirth, preterm birth, and low birth weight or minor deformities in newborns.

Table 5.2 Application of arsenic, source of arsenic pollution/contamination and adverse effects of arsenic on health

Heavy metal	Arsenic
Application	● Arsenic is often used in the manufacture of alloys, hardening of the lead plates in batteries, the outer sheath of electrical cables, etc. ● Inorganic arsenic compounds are primarily used in wood preservatives, while organic arsenic compounds are used as pesticides, primarily on cotton fields and orchards.
Source of pollution/contamination	● Arsenic is a **naturally occurring element in the environment found in the soil, water and air.*** It is generally divided into organic arsenic and inorganic arsenic, **with the latter having a higher toxicity**.
Adverse effects on health	● Chronic arsenic poisoning can cause skin lesions, neurological damage, cancer, and vascular diseases. ● Symptoms of acute arsenic poisoning include severe vomiting and diarrhoea, muscle cramps, facial edema, and heart failure. ● Chronic exposure to or ingestion of arsenic in children, pregnant women, and fetuses can

	cause a decreased intelligence quotient in children and placental transfer of arsenic to fetal tissues. Arsenic is also present in low concentrations in breast milk.

*The arsenic content in crops is associated with the soil, water, air and other growing conditions. The arsenic content in food animals (poultry, livestock, and aquatic food products) is usually related to their feeds, water sources used for their cultivation, quality of seawater and other cultivation conditions and environments.

3. **Smoke point** refers to the temperature at which an oil or fat begins to produce smoke, and each type of oil and fat has its own smoke point. Cooking with an oil or fat above its smoke point can produce various harmful substances which are hazardous to human health. The following are some examples for public reference:

Cooking methods	Temperatures	Suitable edible fats and oils
Garnishing oil for cold dishes or cooked food	< 49 ℃	Olive oil, linseed oil, sesame oil, camellia oil, walnut oil, etc.
Blanching	~ 100 ℃	Sunflower oil, soybean oil, peanut oil, etc.
Pan-frying or stir-frying over medium heat	~ 160 ℃	Soybean oil, peanut oil, corn oil, etc.
Pan-frying, stir-frying or baking at high temperatures	~ 180 ℃	Ghee, palm oil, butter, lard, coconut oil, etc.

July, 2023

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