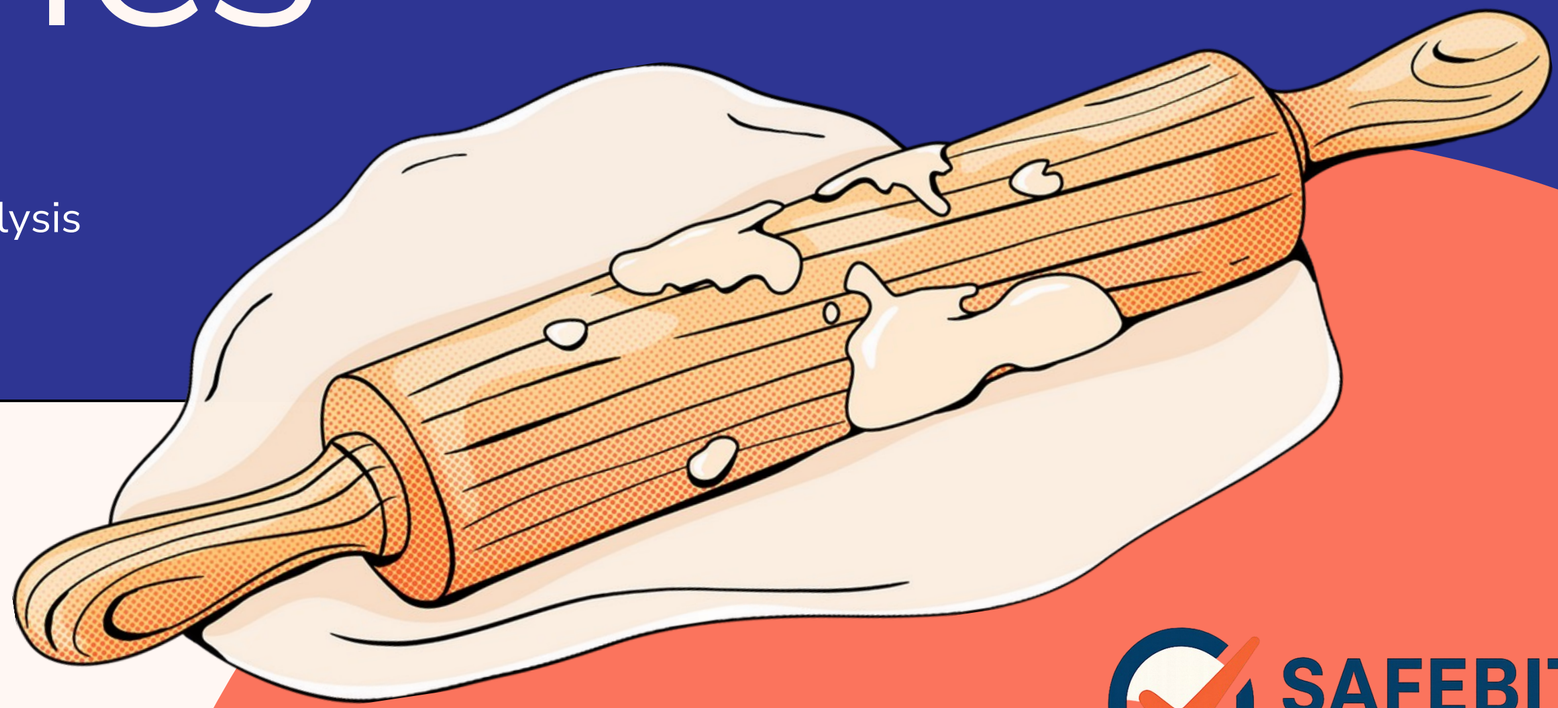
# SAFEBITE ANALYTICS

Detecting the Undetected:

Data-Driven Food Adulteration Analysis



**Karen Amarillys**

FSDA Batch JUN 25

SAFEBITE ANALYTICS

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# Executive summary.

## Problem

**Food adulteration is still widely present**, with common use of unsafe additives (e.g., coloring agents, chalk, artificial sweeteners, water dilution). This **poses significant health risks** ranging from minor to severe.

## Objectives

Finding the **most common products** to be adulterated **and most common adulterants** used for inspections. Also to find the **high-risk brand**.

## Findings

- Juice, chicken, and milk are the most high risk products to be adulterated
- Artificial sweeteners, coloring agents, chalk, and water are the most common adulterants used.
- Brand C has the most cases, making it a high risk brand

## Recommendations

- Prioritize monitoring of coloring agents & chalk (highest severity & frequency).
- Conduct regular and more frequent inspections, especially in non-festive periods.
- Tighten enforcement: fines, product recalls, and penalties for repeat offenders.
- Improve consumer awareness

# Background.

What is food adulteration? And how dangerous is it?

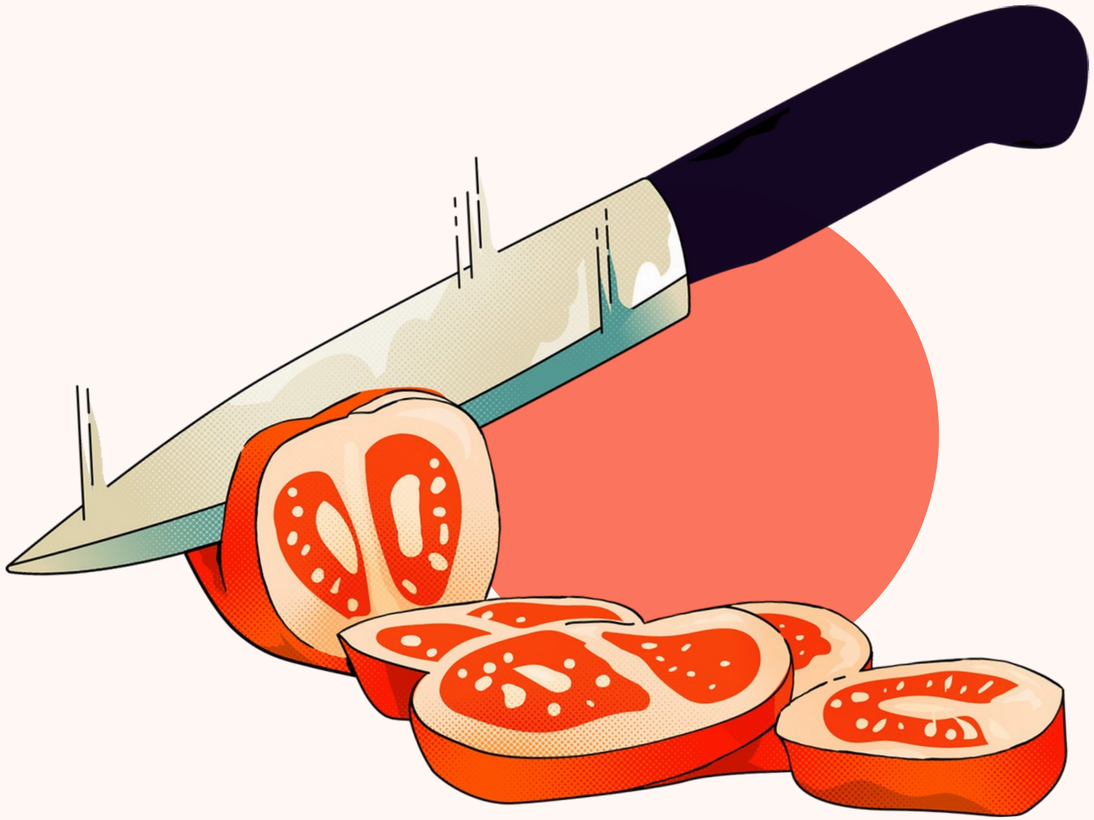
# What is food adulteration?

Food adulteration is the practice of **lowering the quality of food** by adding, mixing, or substituting harmful or cheaper substances, or by removing valuable ingredients.

Examples: mixing water into milk, adding artificial coloring to spices, or using unsafe preservatives to extend shelf life.


# Why is it dangerous?

It is dangerous because adulterated foods **can cause serious health problems**—ranging from stomach upset and food poisoning to long-term effects like organ damage, weakened immunity, or even cancer. It also deceives consumers, reduces nutritional value, and can erode trust in the food supply chain.



# Level of Health Risks

### 🔹 Low Risk

These cases usually **don’t cause direct illness** but still harm consumers by lowering nutrition or misleading them.

Examples:

- Dilution with water in milk or juice → lowers nutrition.
- Excess starch in spices or flour → reduces quality.
- Use of excessive but permitted food coloring → may cause minor digestive discomfort in sensitive people.

Impact: Mostly economic fraud and nutritional loss, with mild short-term health effects.


### 🔸 Medium Risk

Can cause **noticeable health problems**, especially in vulnerable groups (children, elderly, pregnant women, those with allergies).

Examples:

- Non-permitted dyes in spices (e.g., Sudan Red in chili powder, Rhodamine B in candy) → can irritate the stomach and liver.
- Meat substitution (pork/chicken mixed in beef without labeling) → risks allergies, religious violations, and nutrient imbalance.
- Excess preservatives (borax in noodles, formalin in tofu/fish) → may cause nausea, vomiting, or long-term organ stress.

Impact: Can cause digestive issues, allergies, organ strain, and medium-term health risks.

### 🔴 High Risk

**Severe or life-threatening** adulteration, often involving toxic chemicals or dangerous substitution.

Examples:

- Methanol in alcohol → causes blindness or death.
- Melamine in milk (China, 2008 scandal) → kidney damage in infants, some fatalities.
- Heavy metals (lead in turmeric, arsenic in rice) → chronic poisoning, cancer risk.

Impact: Can cause acute poisoning, chronic disease (kidney, liver, cancer), or even death.

# Our current situation.

Food fraud may affect approximately **10% of all commercially sold food products**

Cost the food industry **$10–15 billion** annually

**57% worldwide health problem** estimate from adulterated food

Grocery Manufacturers Association. (2014). *Economic adulteration of food (food fraud)*. Congressional Research Service Report R43358. Retrieved from https://www.everycrsreport.com/reports/R43358.html
Rahman, M. A., Jahan, R., Nahar, J., & Hosen, M. J. (2023). Food adulteration and associated health risks: A global perspective. BMC Public Health, 23(1), 14933. https://doi.org/10.1186/s12889-022-14933-9

# How often are inspections done in Indonesia?

- Routine market inspections are often done before festive seasons like Ramadan and Lebaran.
- Targeted inspections when reports of adulteration/unsafe additives arise.
- No fixed public schedule, but high-risk industries (milk, jamu, packaged foods) are inspected at least once a year, while others less frequently.
- Imports: checked at ports with random sampling.

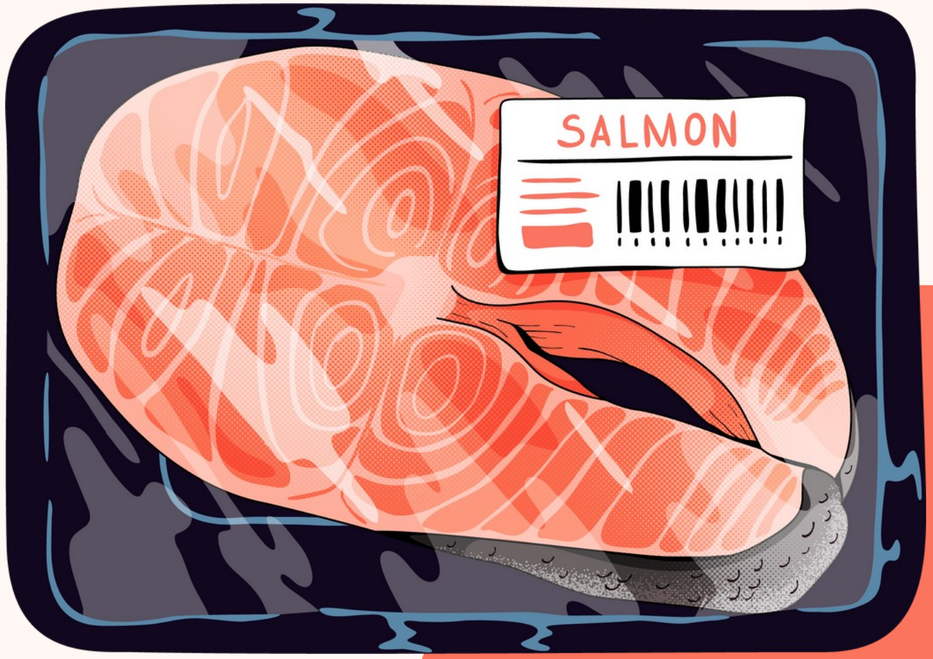

Badan Pengawas Obat dan Makanan Republik Indonesia (BPOM RI). (2025, February 24). Intensifikasi pengawasan pangan: Maksimalkan perlindungan masyarakat selama Ramadan dan Idulfitri. Retrieved from https://www.pom.go.id

World Health Organization (WHO). (2023, November 2). Breaking new ground: Piloting risk-based food inspection in five districts for better food safety. Retrieved from https://www.who.int/indonesia/news/detail/02-11-2023-breaking-new-ground--piloting-risk-based-food-inspection-in-five-districts-for-better-food-safety

Antara News. (2024, December 18). BPOM seizes over 50,000 expired foods ahead of holidays. Retrieved from https://en.antaranews.com/news/338782/bpom-seizes-over-50000-expired-foods-ahead-of-holidays

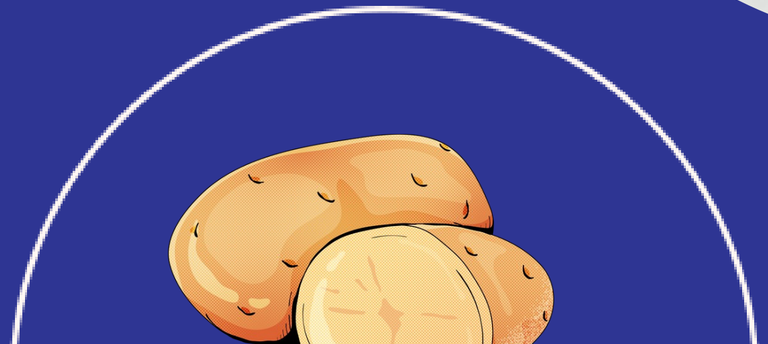
# Business problem.

Problem statement




# Problem statement.

How to reduce food adulteration incidents by at least 20% within 1 year?



# Project scope.

## focus area

1. Identify the **most common product** that consists adulterant
2. Identify the **most common adulterant**
3. Pinpointing **high risk brands**

## exclusions

- Prediction of long-term health effects (would require medical datasets).
- Sensory quality testing (taste, smell)

# Methodology.

1. Problem Understanding

Understanding the business probelms

2. Data Cleaning

Make sure the data is clean,  no duplicates, missing values, or any typographical errors.

3. Data Analysis

Understanding the big picture of the data

4. Data Visualization

Make sure the data is clean,  no duplicates, missing values, or any typographical errors.

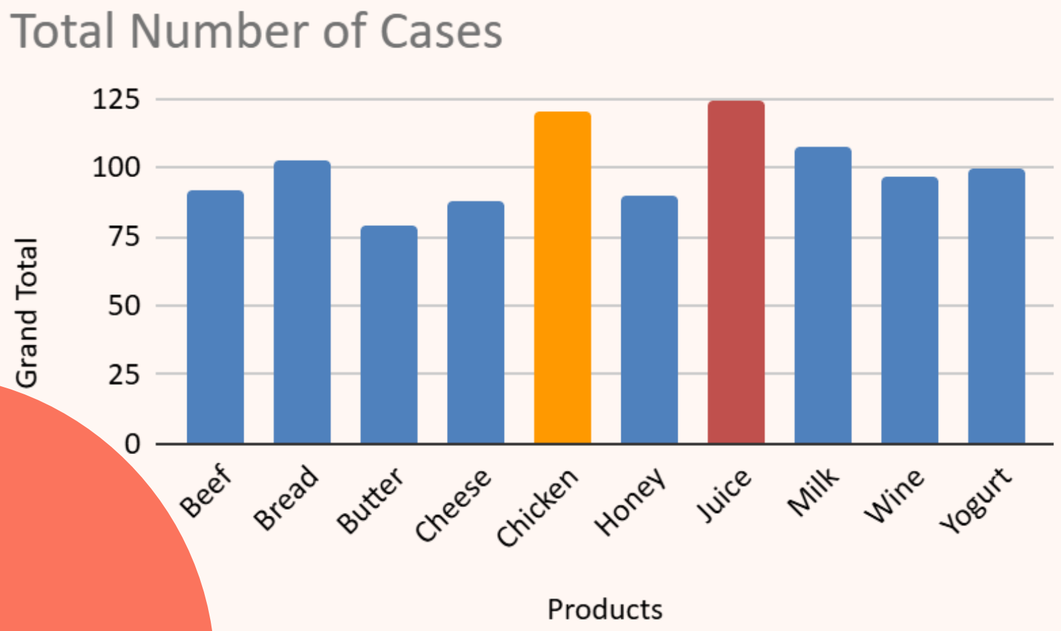
5. Insights and Recommendations

Generating overall insights and giving executable recommendations

# Analysis Results.

# Most common products with adulterants.

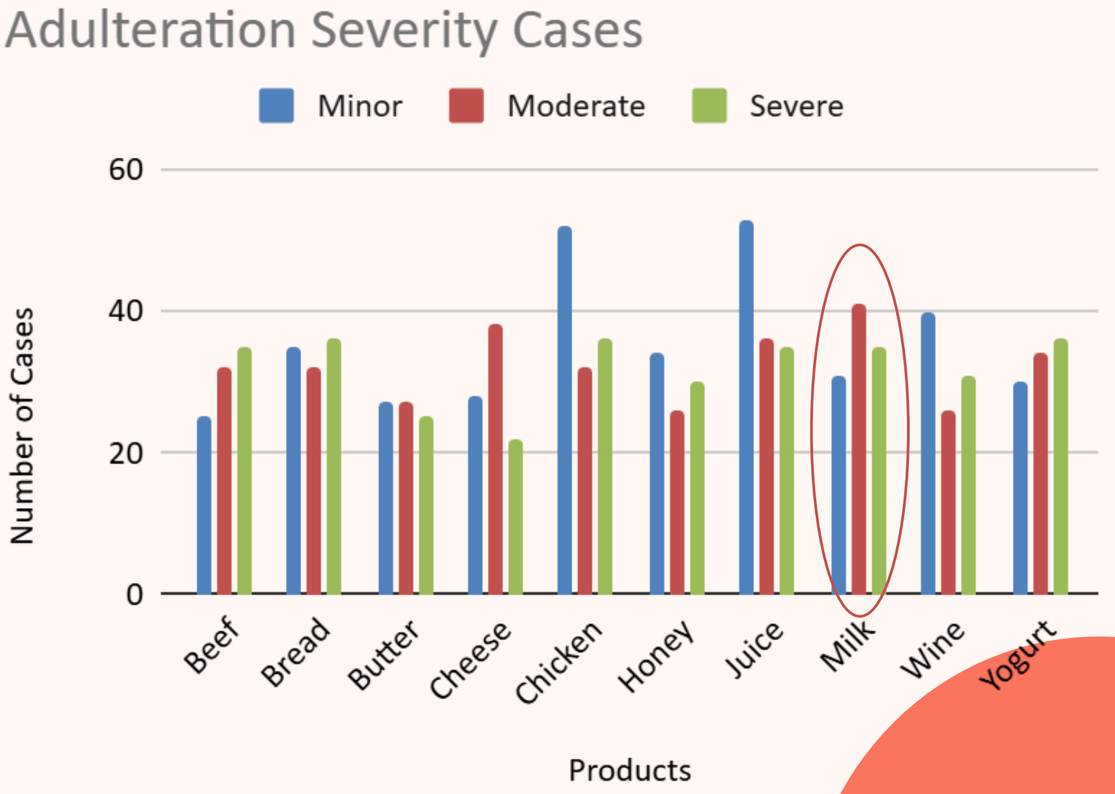
**Juice** with **124 cases** and **chicken** with **120 cases**




| Products | Grand Total |
|---|---|
| Beef | 92 |
| Bread | 103 |
| Butter | 79 |
| Cheese | 88 |
| Chicken | 120 |
| Honey | 90 |
| Juice | 124 |
| Milk | 107 |
| Wine | 97 |
| Yogurt | 100 |

# Most common products with adulterants (severity).

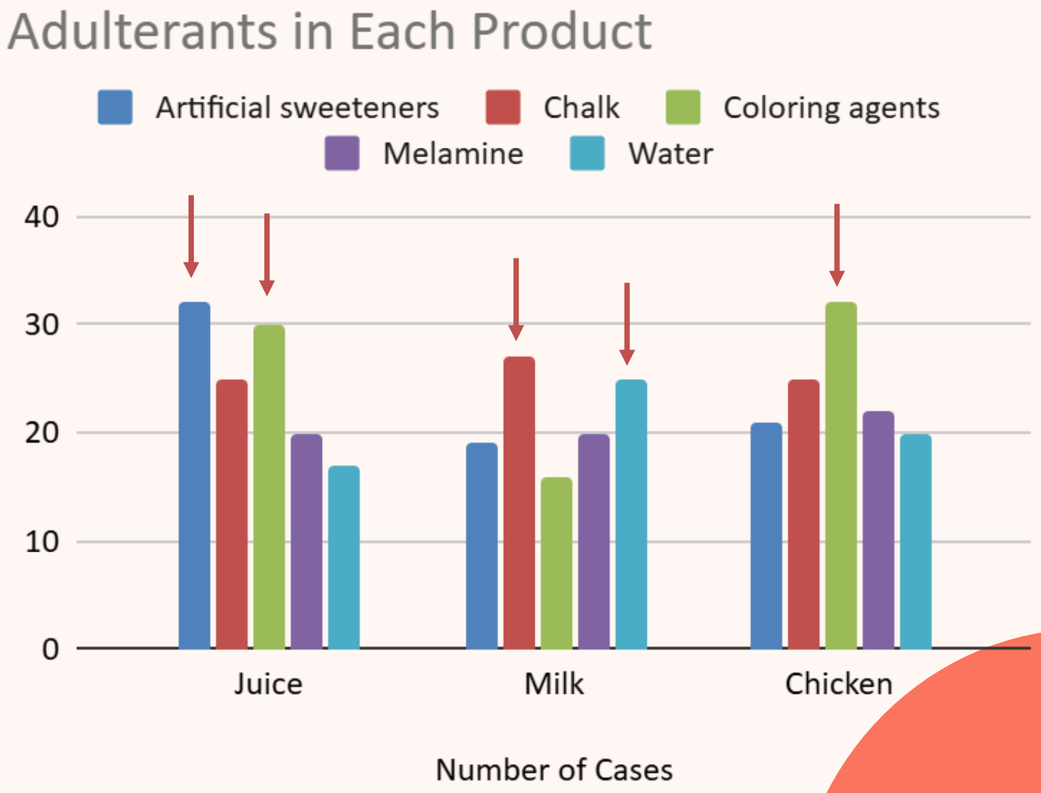
| Products | Minor | Moderate | Severe |
|---|---|---|---|
| Beef | 25 | 32 | 35 |
| Bread | 35 | 32 | 36 |
| Butter | 27 | 27 | 25 |
| Cheese | 28 | 38 | 22 |
| Chicken | 52 | 32 | 36 |
| Honey | 34 | 26 | 30 |
| Juice | 53 | 36 | 35 |
| Milk | 31 | **41** | 35 |
| Wine | 40 | 26 | 31 |
| Yogurt | 30 | 34 | 36 |




Chicken and Juice have highest overall cases with highest number of minor cases. However, **milk** products also have a high number on **moderate cases**, which also requires attention.

# Most common adulterants in those products.

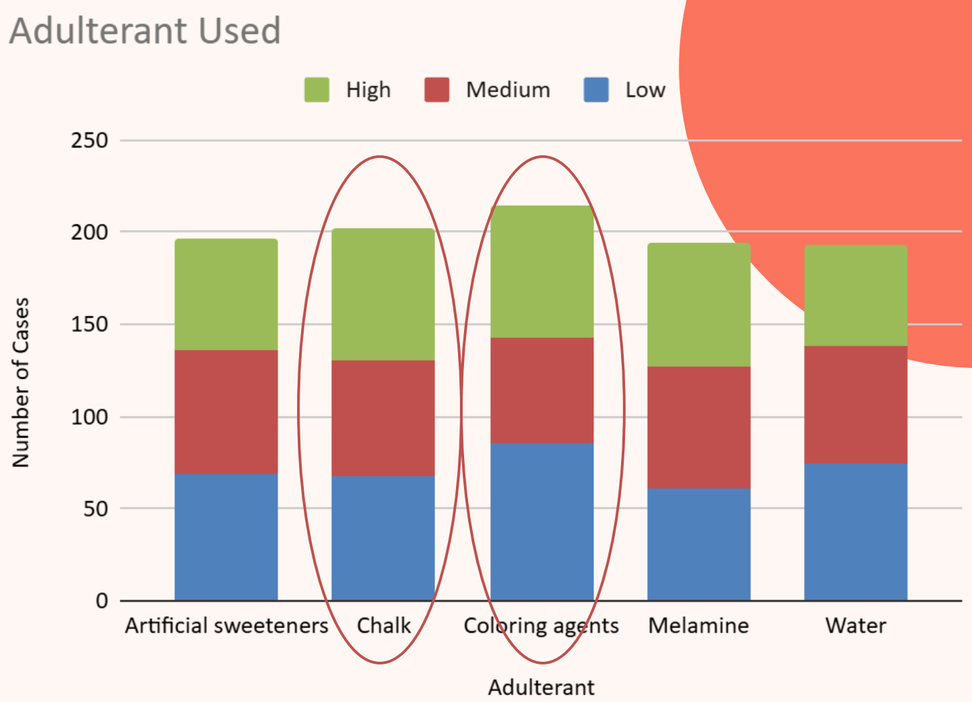
| *Product* | Artificial sweeteners | Chalk | Coloring agents | Melamine | Water |
|---|---|---|---|---|---|
| Juice | **32** | 25 | **30** | 20 | 17 |
| Milk | 19 | **27** | 16 | 20 | **25** |
| Chicken | 21 | 25 | **32** | 22 | 20 |




- Juice → Artificial sweeteners & coloring agents
- Milk → Chalk & water
- Chicken → Coloring agents

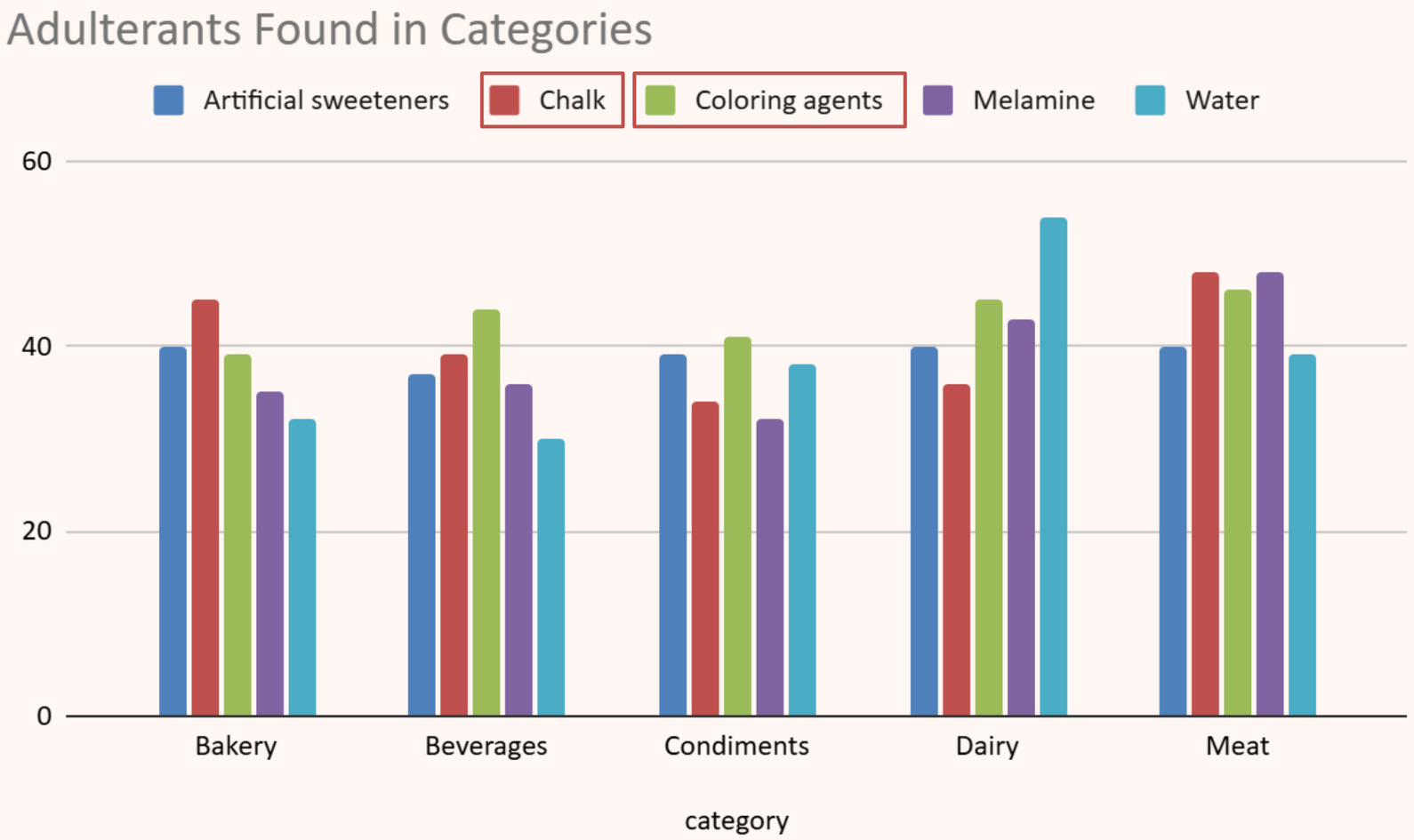
# Most common adulterants used overall.

| Adulterant | Low | Medium | High | Grand Total |
|---|---|---|---|---|
| Artificial sweeteners | 69 | 67 | 60 | 196 |
| Chalk | 68 | 63 | 71 | **202** |
| Coloring agents | 86 | 57 | 72 | **215** |
| Melamine | 61 | 66 | 67 | 194 |
| Water | 74 | 64 | 55 | 193 |




**Coloring agents** are the most common adulterants used, found in **215 cases**, with highest number of cases with **low and high health risk cases**. Followed by **chalk** with **202 cases** and fairly balanced cases distribution through all health risks.

# Mostly found in... (category)

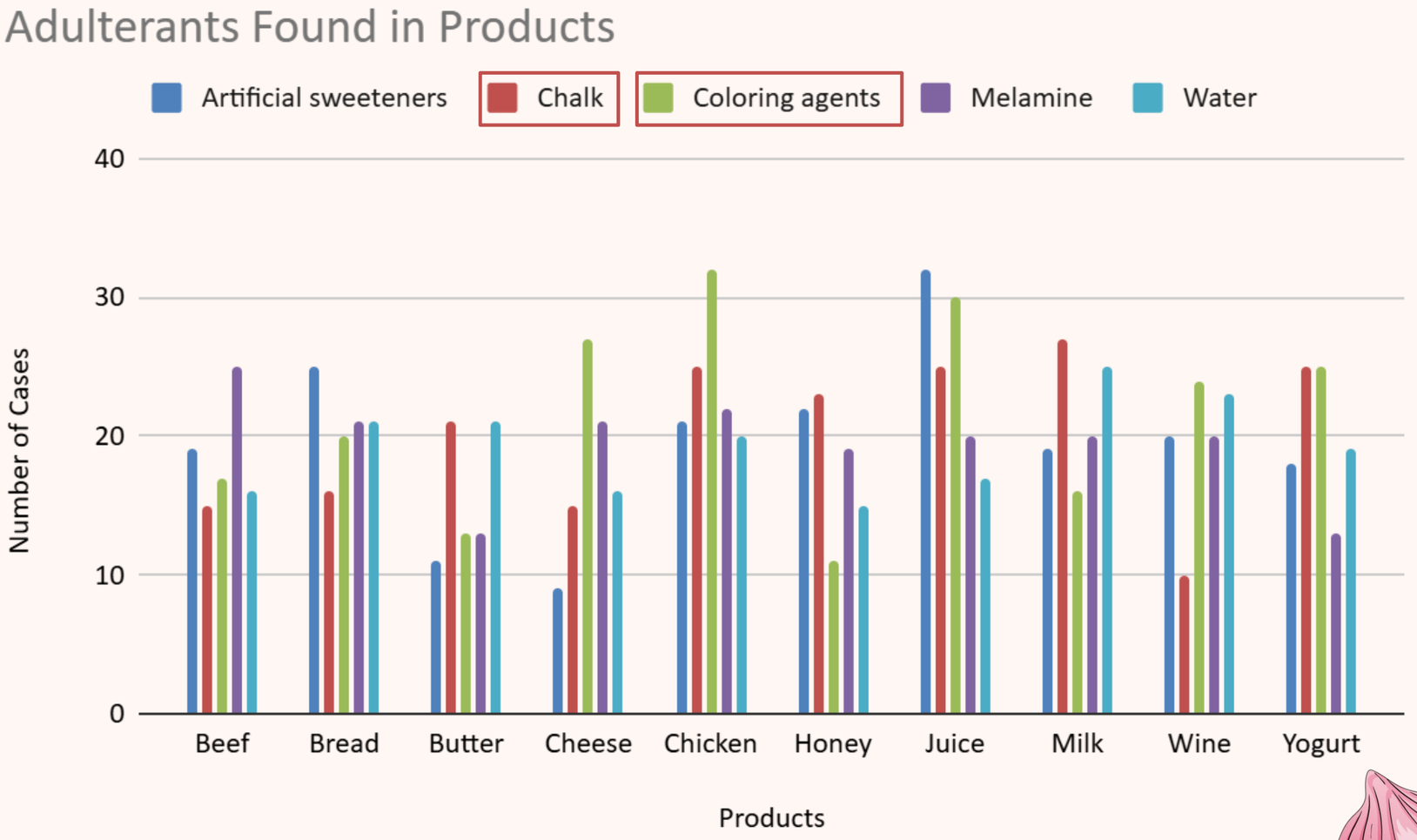



**Coloring agents** are found almost **evenly distributed** in all categories, but **highest in meat**.

**Chalk** is mostly found in **meat and bakery**.

The other notable one is **water** adulterant in **dairy**.

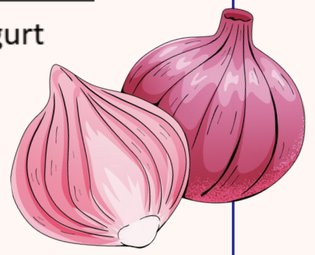
# Mostly found in... (product)

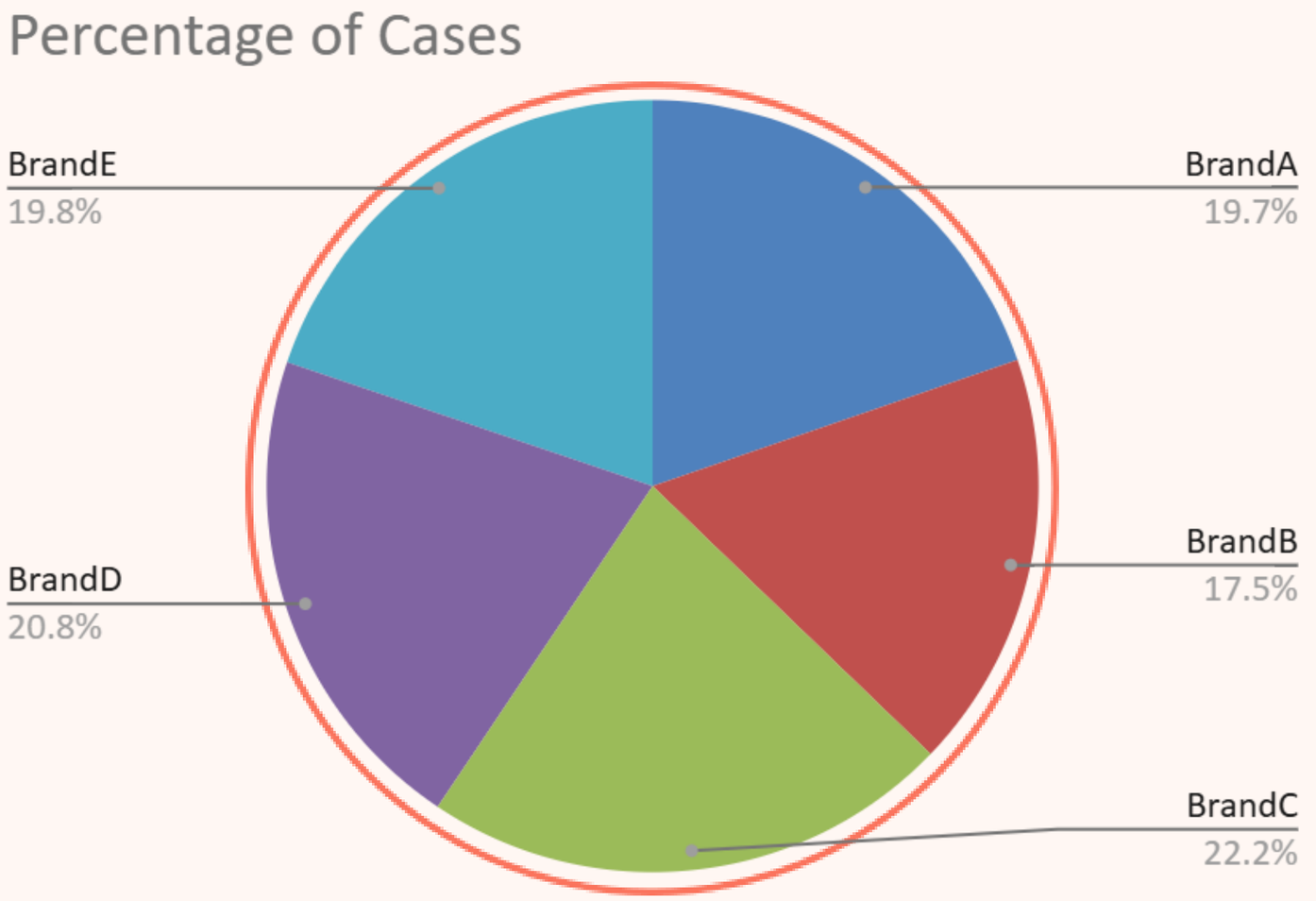



**<u>Coloring agents</u>** are mostly found in **chicken, juice, cheese, yogurt, and wine.**

Meanwhile, **<u>chalks</u>** are commonly found in **milk, juice, chicken, and yogurt**.

The other notable adulterant is **<u>artificial sweeteners</u>** in **juice**

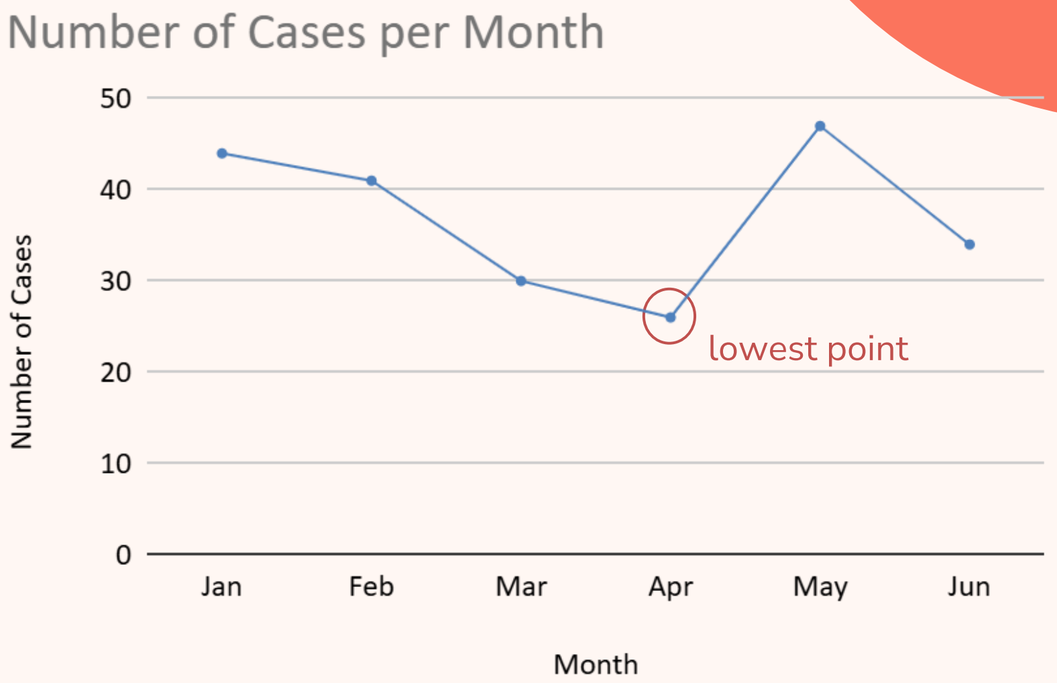


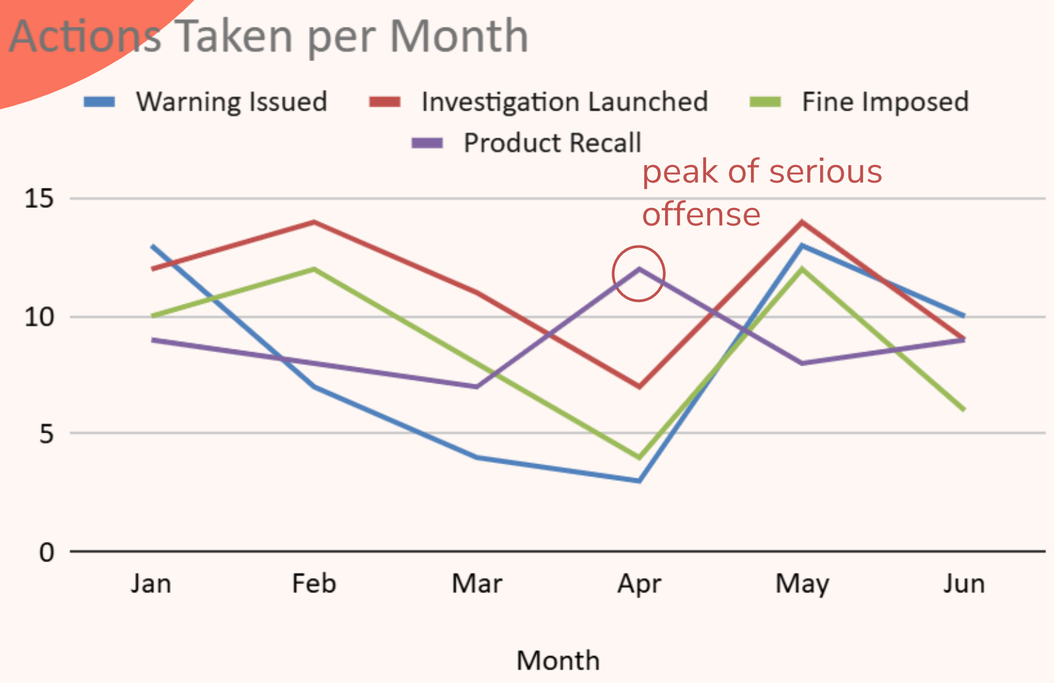



# High risk brands.

Most of them are almost evenly distributed. But **Brand C** had the **most cases** amongst them

# Brand C case trend.



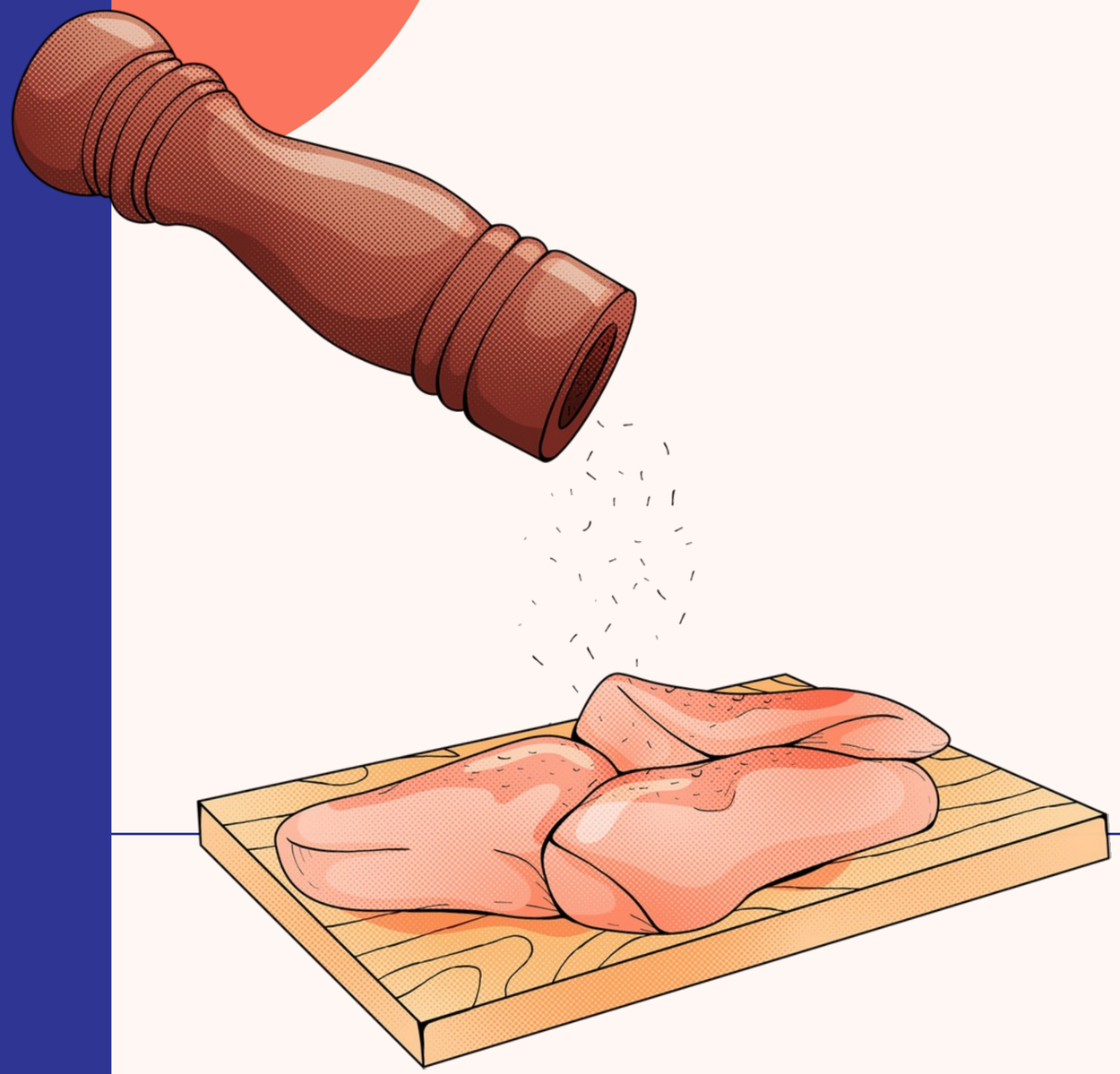

There was **a rise** in number of cases in **January and May** with a **drop** in **April**.

*However, the number of cases seems to follow inspection intensity, not just actual adulteration levels.

On the other hand, there's **a surge of product recall** (most serious action) in **April** instead.

# Recommended actions.

How to possibly reduce the number of cases?



**Products:**

Juice

Chicken

Milk

**Adulterants:**

Coloring agents

Artificial sweeteners

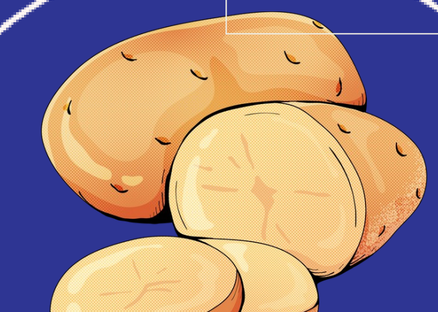
Chalk

Water

# Where to keep an eye on?

# What to do?

| | **O**bservation | **B**usiness Impact | **I**solation | **P**rioritization | **R**ecommendation |
|---|---|---|---|---|---|
| Coloring Agents | Coloring agents are the most common adulterant (215 cases), especially in chicken and juice. | Illegal dyes are often added to make products look fresher or more attractive. | The root cause is economic motivation to improve appearance cheaply, exploiting the difficulty for consumers to detect unsafe dyes. | Top priority → highest number of cases + high-severity risks. | Strict ban on non-food dyes, targeted inspections, consumer education. |
| Chalk | Found mostly in milk, juice, chicken, and yogurt. | Added to mimic protein/calcium; reduces nutrition, may cause kidney stones. | Cheap filler substitution in dairy. | High priority → second highest frequency, medium-to-high health risks. | Routine inspections, penalties for fillers, promote simple home detection methods. |
| Artificial Sweeteners | Most found in juice | Used to reduce sugar costs, often undeclared on labels. | Weak labeling enforcement + consumer unawareness. | Medium priority → frequent but mostly medium-risk cases (metabolic impacts, long-term). | Mandatory disclosure, beverage testing, fines for undeclared additives, consumer campaigns. |
| Water Dilution | Most common in dairy products. | Dilution increases volume; unsafe water raises contamination risk. | Lack of clear dilution standards + poor hygiene in practices. | Lower priority → frequent but usually low-to-medium risk, unless unhygienic. | Define legal dilution thresholds, deploy rapid-test kits, enforce hygiene in dairy/beverage chains. |



# Insights and recommendations

## (based on Brand C trend).

- **Regular & Frequent Inspections**
  - Move beyond only seasonal campaigns (Ramadan, Eid, etc.).
  - Implement inspections per semester or per quarter, especially for high-risk foods (milk, chicken, juice).

- **Adaptive Risk-Based Scheduling**
  - Increase inspection frequency if severe cases are detected in prior months.
  - Keep baseline inspections year-round to avoid “inspection gaps” that allow adulteration to resurface.

- **Early Warning System**
  - Use data trends to predict months where adulteration risk rises (e.g., supply chain stress, high demand).
  - Adjust inspection resources accordingly.

Dashboard preview.

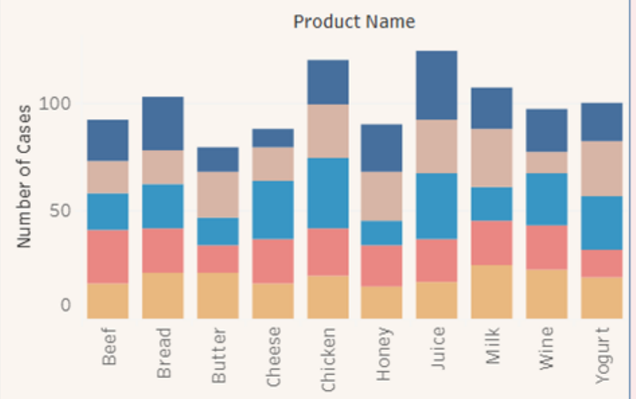
SAFEBITE ANALYTICS

# 2025 SEMESTER 1 ANALYSIS DASHBOARD

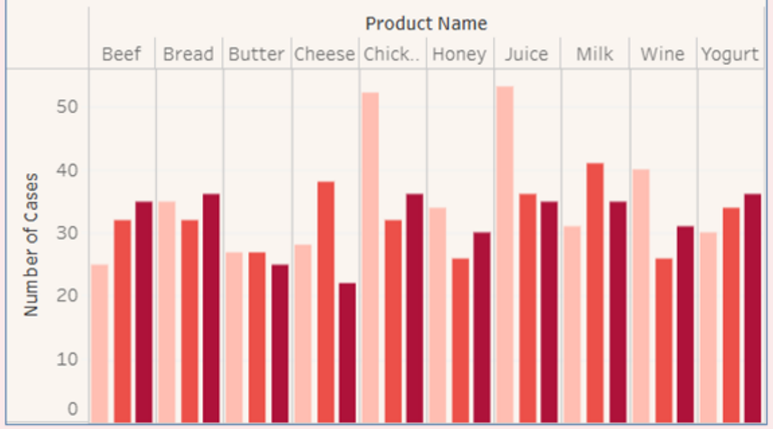
## Number of Cases per Products

| Product Name | |
|---|---|
| Beef | 92 |
| Bread | 103 |
| Butter | 79 |
| Cheese | 88 |
| Chicken | 120 |
| Honey | 90 |
| Juice | 124 |
| Milk | 107 |
| Wine | 97 |
| Yogurt | 100 |

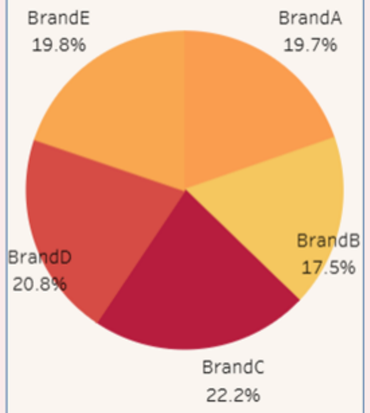
## Cases per Products



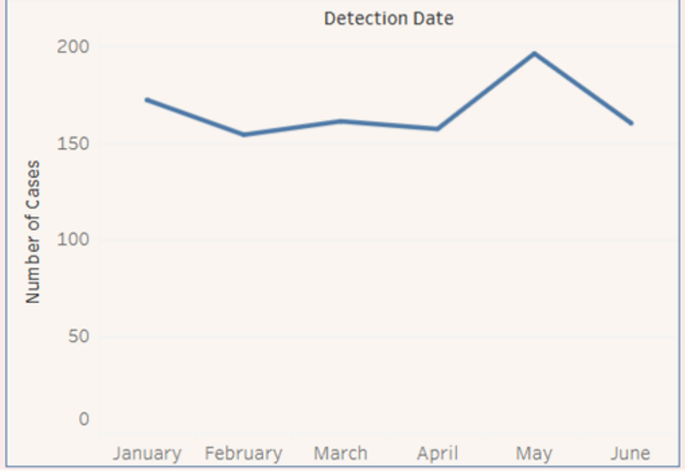

## Cases Based on Severity



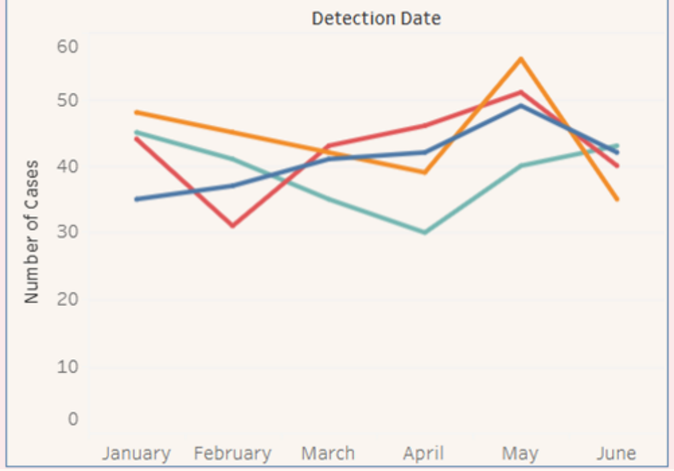

## Offender's Percentage




## Cases Trend




## Actions Taken Trend




Count of Adulteration Id
1,000

Product Name
(All)

Brand
- (All)
- BrandA
- BrandB
- BrandC
- BrandD
- BrandE

Severity
- (All)
- Minor
- Moderate
- Severe

Adulterant
- Artificial sweeteners
- Chalk
- Coloring agents
- Melamine
- Water

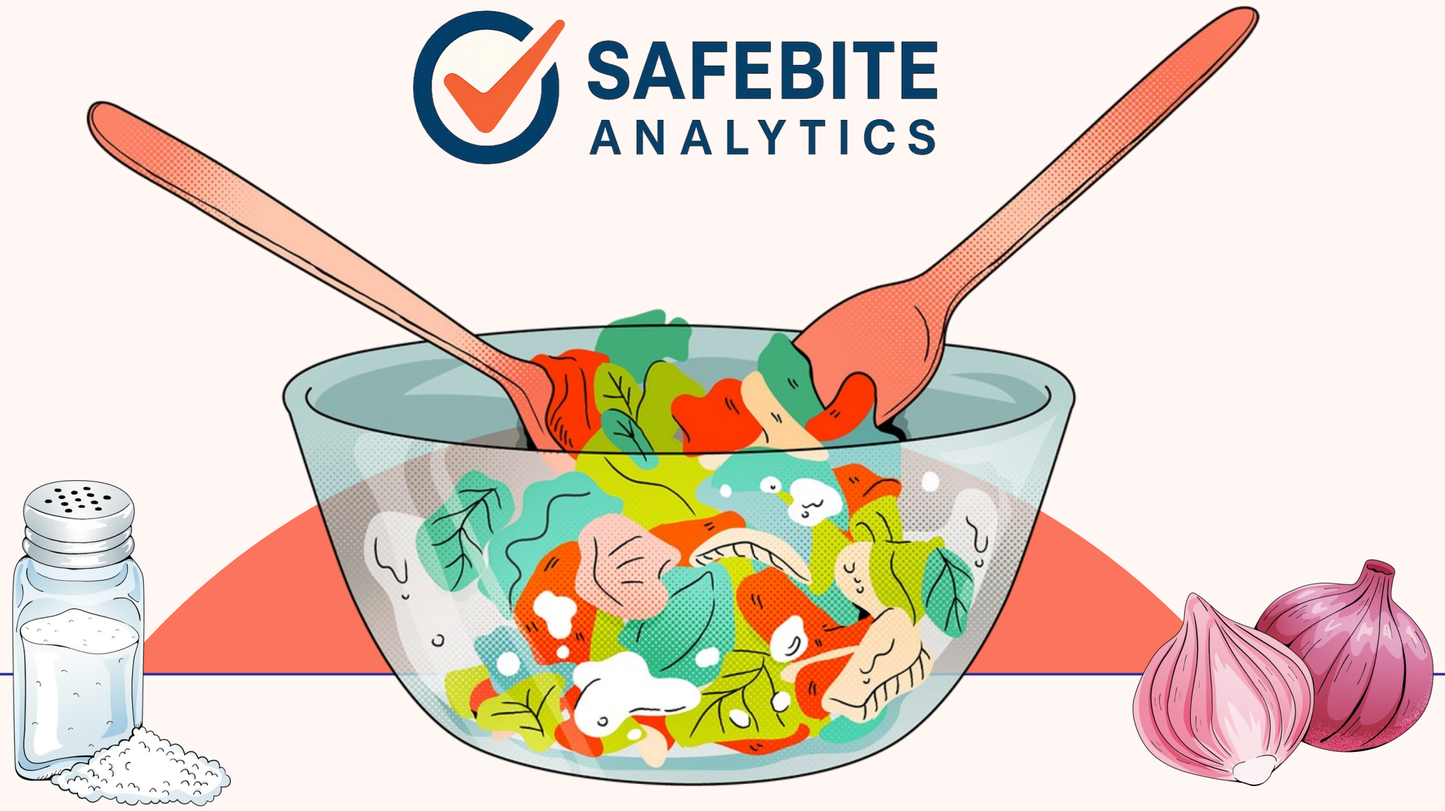
Severity
- Minor
- Moderate
- Severe

Action Taken
- Fine Imposed
- Investigation Launched
- Product Recall
- Warning Issued

# THANK YOU

linkedin.com/in/karen-amarillys/

SAFEBITE ANALYTICS



# Appendix.

Dataset

Data Preparation (Spreadsheet)

Dashboard

# Our business model.

| | |
|---|---|
| **Key Activities** | 1. Process and analyze per-sample data<br>2. Generate reports for regulatory action and compliance |
| **Customer Segment** | Regulators |
| **Revenue Stream** | Pay-per-analysis |


D - **DECISION MAKER**

➔ Food Safety Regulatory Agencies

A - **ACCOUNTABLE**

➔ Safebite Analytics project manager

R - **RESPONSIBLE**

➔ Safebite Analytics team (data analysts, data engineers, and laboratory technicians)

C - **CONSULTED**

➔ Food scientists, nutritionists and quality assurance managers

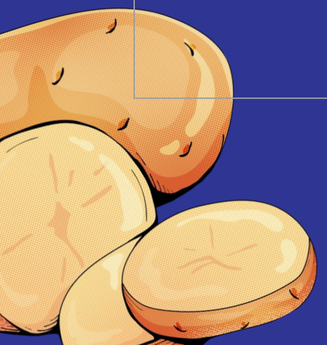
I - **INFORMED**

➔ Consumers

# Step-by-step.

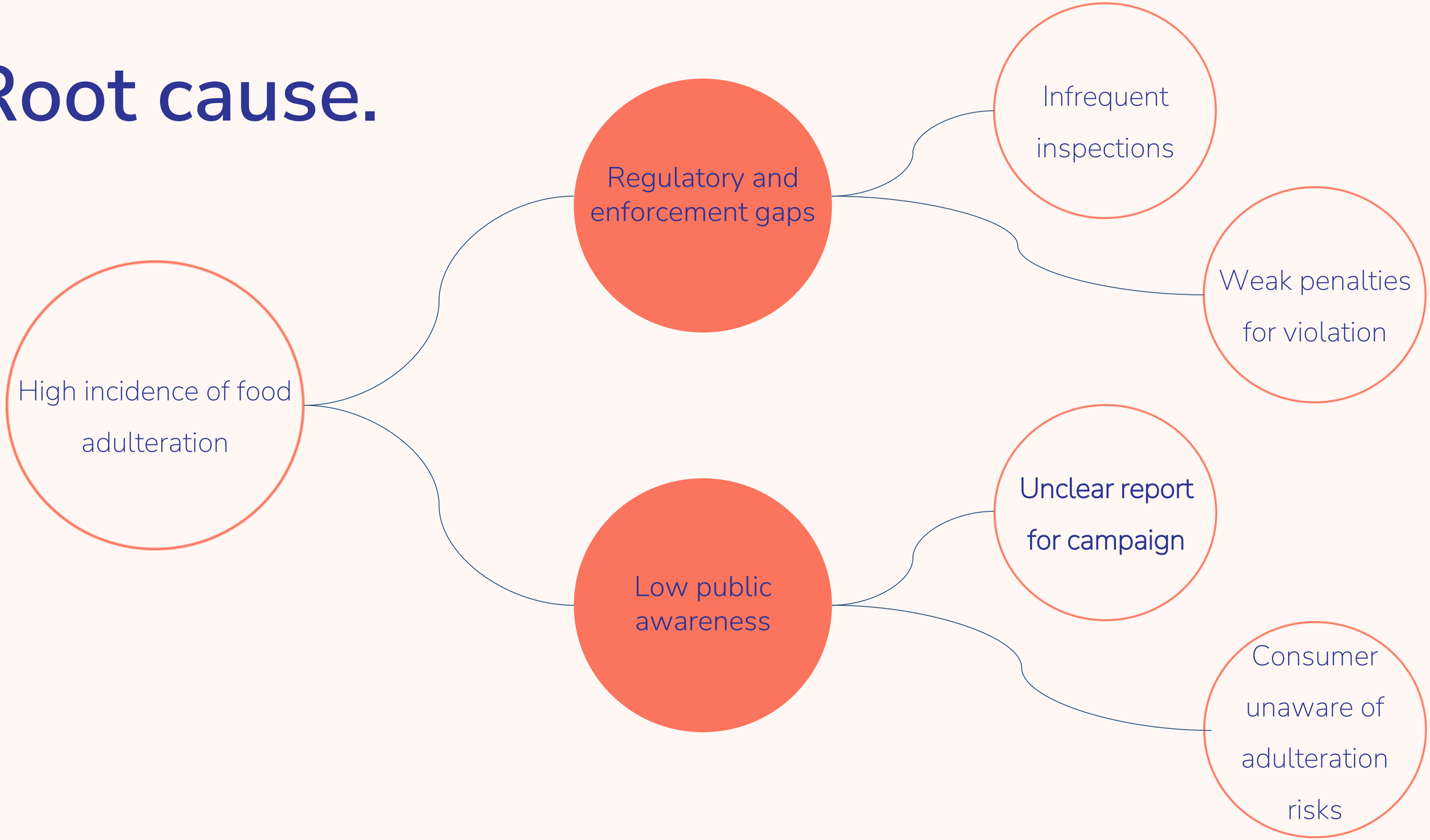
| | |
|---|---|
| **Converting** | Convert CSV file data into Excel using Python and import them to Google Sheets |
| **Data Cleaning** | 1. Make sure the data is clean, no duplicates, missing values, or any typographical errors.<br>2. Remove unnecessary column (removed unnamed: 0 column from data conversion).<br>3. Format each data type to their own requirements (formatted detection_date column into date) |
| **Sort and Filter** | Sort and filter data for EDA |

| Root Cause | Hypothesis | Priority |
|---|---|---|
| Infrequent inspections | If food safety inspections occur infrequently, then more adulterated products will remain undetected in the market, increasing consumer exposure to unsafe food. | moderately feasible to address |
| Weak penalties for violation | If penalties for food adulteration violations are weak or inconsistently enforced, then food producers will have little incentive to comply with safety standards | moderately feasible to address |
| **Unclear report for campaigns** | **If analysis reports on food adulteration are too technical or unclear, then regulators and NGOs will be less effective in using them for public awareness campaigns** | **most feasible to address** |
| Consumer unaware of adulteration risks | If consumers are unaware of the risks of food adulteration, then they are less likely to demand safer products or avoid high-risk brands, reducing market pressure on producers to maintain quality. | least feasible to address |



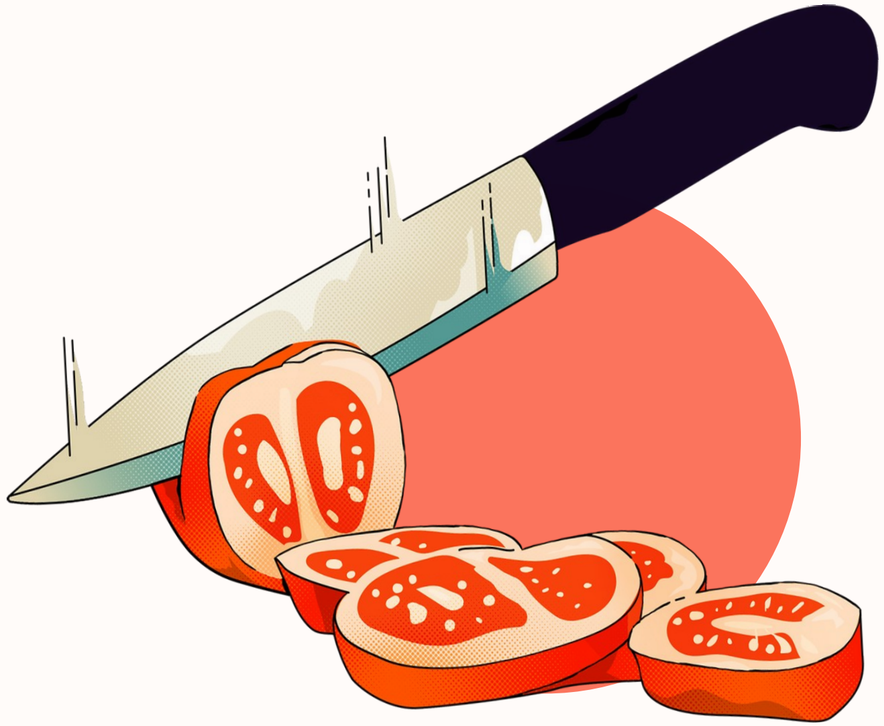
| Prioritized Hypotheses | Metrics | Reasoning |
|---|---|---|
| If food safety inspections occur infrequently, then more adulterated products will remain undetected in the market, increasing consumer exposure to unsafe food | # Risk-based inspection recommendations issued per semester | Tracks how many times our analysis system identifies specific products, brands, or categories as high-risk and then formally recommends that regulators (or food safety authorities) inspect them |
| If penalties for food adulteration violations are weak or inconsistently enforced, then food producers will have little incentive to comply with safety standards | Repeat-offender rate | If penalties deter, repeats should fall; a stubborn or rising rate signals weak consequences |
| If analysis reports on food adulteration are too technical or unclear, then regulators and NGOs will be less effective in using them for public awareness campaigns | Stakeholder usefulness score (1–5) from NGOs/regulators | To confirm whether our clients understand the report and able to use them efficiently |

# Root cause.


High incidence of food adulteration
Regulatory and enforcement gaps
Infrequent inspections
Weak penalties for violation
Low public awareness
Unclear report for campaign
Consumer unaware of adulteration risks

# Project scope.

dataset contents



- **adulteration_id:** Unique identifier for each instance of adulteration.
- **product_name:** Name of the food product.
- **brand:** Brand name of the product.
- **category:** Category of the food product (e.g., dairy, meat, beverages).
- **adulterant:** Substance found as an adulterant.
- **detection_date:** Date when the adulteration was detected.
- **detection_method:** Method used to detect the adulteration (e.g., chemical analysis, sensory evaluation).
- **severity:** Severity level of the adulteration (e.g., minor, moderate, severe).
- **health_risk:** Health risk associated with the adulterant (e.g., low, medium, high).
- **action_taken:** Action taken after detection (e.g., product recall, warning issued).

# Adulterant cases in each product.

| Product | Artificial sweeteners | Chalk | Coloring agents | Melamine | Water | Grand Total |
|---|---|---|---|---|---|---|
| Beef | 19 | 15 | 17 | 25 | 16 | 92 |
| Bread | 25 | 16 | 20 | 21 | 21 | 103 |
| Butter | 11 | 21 | 13 | 13 | 21 | 79 |
| Cheese | 9 | 15 | 27 | 21 | 16 | 88 |
| Chicken | 21 | 25 | 32 | 22 | 20 | 120 |
| Honey | 22 | 23 | 11 | 19 | 15 | 90 |
| Juice | 32 | 25 | 30 | 20 | 17 | 124 |
| Milk | 19 | 27 | 16 | 20 | 25 | 107 |
| Wine | 20 | 10 | 24 | 20 | 23 | 97 |
| Yogurt | 18 | 25 | 25 | 13 | 19 | 100 |
| **Grand Total** | **196** | **202** | **215** | **194** | **193** | **1000** |

# Adulterant cases in each product.

| Category | Artificial sweeteners | Chalk | Coloring agents | Melamine | Water | Grand Total |
|---|---|---|---|---|---|---|
| Bakery | 40 | 45 | 39 | 35 | 32 | 191 |
| Beverages | 37 | 39 | 44 | 36 | 30 | 186 |
| Condiments | 39 | 34 | 41 | 32 | 38 | 184 |
| Dairy | 40 | 36 | 45 | 43 | 54 | 218 |
| Meat | 40 | 48 | 46 | 48 | 39 | 221 |
| **Grand Total** | **196** | **202** | **215** | **194** | **193** | **1000** |

# Cases on each brands.

| Brand | High | Low | Medium | Grand Total |
|---|---|---|---|---|
| BrandA | 58 | 71 | 68 | 197 |
| BrandB | 51 | 65 | 59 | 175 |
| **BrandC** | **77** | **69** | **76** | **222** |
| BrandD | 66 | 77 | 65 | 208 |
| BrandE | 73 | 76 | 49 | 198 |
| **Grand Total** | **325** | **358** | **317** | **1000** |

| Brand | Minor | Moderate | Severe | Grand Total |
|---|---|---|---|---|
| BrandA | 75 | 68 | 54 | 197 |
| BrandB | 65 | 52 | 58 | 175 |
| **BrandC** | **81** | **70** | **71** | **222** |
| BrandD | 68 | 70 | 70 | 208 |
| BrandE | 66 | 64 | 68 | 198 |
| **Grand Total** | **355** | **324** | **321** | **1000** |