Asian Agricultural Research 2023, 15 (8): 55 - 58 DOI: 10.19601/j.cnki.issn1943 - 9903.2023.08.012

Sampling Methods and Countermeasures for Food Enterprises

Peng WAN, Zhen ZHAO, Guoyan WEN, Yunshuang FU, Cuizhi LI*, Zhiyong LU

Inner Mongolia Yili Industrial Group Co. Ltd., Hohhot 010010, China

Abstract In this paper, by combining sampling methods for food statistics with years of sample sampling experience, various sampling points and corresponding sampling methods are summarized. It hopes to discover food safety risks and improve the level of food safety.

Key words Food sampling, Sampling method, Sampling points, Food safety

1 Introduction

With the development of China's economy, the variety of food is becoming increasingly diverse, and food safety issues occur from time to time. Food companies have also invested a lot of resources in product testing, but the results have not been satisfactory[1]. Many products have passed factory inspections, but were found to be unqualified during random inspections by regulatory authorities[2]. This situation is likely due to the lack of representativeness in sample collection or the failure to collect high-risk samples[3], resulting in the product still not meeting national food safety standards despite being tested as qualified, causing harm to consumers and greatly affecting the brand image of the enterprise[4]. In this paper, by combining statistical sampling methods with years of sample sampling experience, various sampling points and corresponding sampling methods are summarized, hoping to inspire others.

2 Statistical sampling methods

Sampling types can be divided into census and sampling survey based on sample coverage. A census refers to a one-time comprehensive survey organized specifically for a specific purpose, used to investigate the total amount of phenomena at a certain point in time or within a certain period of time. Sampling survey refers to a data survey method that uses a certain procedure to select a portion of units from the population as a sample for investigation, and infers the overall characteristics based on the sample survey results. Product sampling of food enterprises belongs to sampling survey[5]. Sampling survey methods are divided into probability and non probability sampling. Probability sampling is usually used to calculate the representative situation of the sample to the product, and is generally used to evaluate the overall situation of the corresponding batch of products, while non probability sampling is used to evaluate the product situation at high-risk points[6].

Received: April 5, 2023 Accepted: July 24, 2023

Peng WAN, engineer, master, research fields: food safety management.

* Corresponding author. Cuizhi LI, senior engineer, master, research fields: food safety management.

2.1 Probability sampling Probability sampling refers to sampling that follows the principle of randomness, where each unit in the population has a certain chance of being selected into the sample.

2.1.1 Random sampling. Random sampling refers to the direct collection of samples from a population, with each individual having an equal probability of being selected. Market supervision administrative departments mostly use this method for conducting spot checks.

2.1.2 Layered sampling. Layered sampling, also known as type sampling, refers to dividing the population into different layers (groups) according to a certain feature or rule, collecting samples independently and randomly from each layer (group) in an equal or optimal proportion, and finally combining the samples from each layer to estimate the target quantity of the population. If sampling is done according to different production lines, one sample is collected from each production line per day. If sampling is carried out according to different product categories, one sample is collected daily for prepared milk, fermented milk, and milk drinks.

2.1.3 Cluster sampling. Cluster sampling refers to the sampling method of dividing a population into several groups, randomly selecting one or several groups in a certain way, and then conducting surveys on all individuals in the selected groups. For example, sensory sampling of certain products is carried out in this way. A box of products are selected from a batch, and the sensory properties of all products in that box are detected as the result of that batch of products.

2.1.4 Systematic sampling. Systematic sampling, also known as equidistant sampling, refers to the sampling method of arranging the population in a certain order, determining a random starting point according to rules, and collecting samples one by one at regular intervals. For example, sampling is conducted every 2 h or every 200 products.

2.2 Non probability sampling Non probability sampling refers to the method by which investigators extract samples based on their own convenience or subjective judgment. It does not select samples strictly according to the random sampling principle, so it loses the existence basis of the law of large numbers, and it is impossible to determine the sampling error and correctly explain the extent to which the statistical values of samples are suitable for the population. However, non probability sampling can focus on monitoring high-risk process points, making it easier to detect occasional food safety risks.

2.2.1 Importance sampling. Importance sampling is a non probability sampling method that sets sampling points with a certain purpose based on experience, judgment, risk assessment conclusions, and conducts systematic or non systematic collection of samples at the sampling points. This method is not suitable for evaluating the overall sample quality risk situation, but is suitable for capturing risk points, evaluating high-risk points, and other situations. For example, the sampling in the startup sample is used to detect total solids.

2.2.2 Snowball sampling. After detecting abnormalities in the sample, based on the information provided by the initial sample, more samples are obtained near its production time point or sampling point by expanding the sampling range, increasing the sampling quantity, increasing the sampling frequency, *etc.* The process is continued until the sampling can reflect the overall risk situation. This sampling type is used when discovering product anomalies and can increase the exclusion range.

2.2.3 Traceability sampling. Traceability sampling refers to the type of further sampling conducted on the relevant raw materials, raw milk, auxiliary materials, process equipment, environment, *etc.* of abnormal samples for the purpose of identifying and investigating the cause of the abnormality.

In the actual sampling process, the above sampling types can be combined to make the sampling representative and easy to identify risk points. In the process of collecting and executing various product samples, if there are special requirements for sampling points, it needs to be clearly defined in the sampling related documents. For projects without special requirements, simple random sampling is adopted, and the representativeness of the samples is considered during collection.

3 Risk analysis of various nodes in the production process

In the production process of food, due to specific production processes, the entire batch of products do not have complete uniformity. Therefore, it is necessary to select appropriate sampling methods based on the characteristics of the process, so that the test results can truly reflect the situation of the product.

3.1 Startup sample Startup sample refers to the product that is continuously produced during the process from equipment startup to product stability. Usually, there is a low risk of conventional physical and chemical indicators, and key sampling methods can be used to detect corresponding products[7].

3.2 First sample The first sample refers to the first product produced after operations such as topping, tank replacement, cleaning, and equipment maintenance. When defining, the first sample can be clearly defined based on the actual production process scenario, such as the first sample of starting the machine, the first sample of top material, and the first sample of changing the tank. Usually, due to factors such as topping and cleaning, nutrients and conventional physicochemical indicators are low, while sweeteners and pigments may be mixed into other products due to residual cleaning and topping material residue. Key sampling methods can be used to detect corresponding products.

3.3 Shutdown sample Shutdown samples refer to products produced within a certain period of time before the equipment ends production. Key sampling methods can be used to detect corresponding products.

3.4 Abnormal pattern Abnormal samples refer to any product whose detection indicators do not meet the requirements. The scope of testing needs to be expanded, and the snowball sampling method can be used to test the corresponding products.

3.5 Change abnormal sample Change abnormal samples refer to samples that occur during equipment major repairs, changes in sterile components, changes in sterile parameters, changes in packaging materials, changes in packaging material sterilization processes, changes in important product indicators, resumption of production of discontinued equipment, and abnormal situations. In many cases, the entire batch of samples are qualified, but once there are changes or abnormalities in the production process, it may cause the products to be unqualified within the corresponding time period. Therefore, it is necessary to strengthen testing of these products. Key sampling methods can be used to detect corresponding products.

3.6 Advent sample Advent samples refer to products that are nearing their expiration date according to the product shelf life regulations. Usually, it is possible that vitamin degradation, packaging factors, or product storage temperatures do not meet the requirements, resulting in products that pass factory testing but still fail after being placed for a period of time. Therefore, it is necessary to strengthen the monitoring of advent samples and control the entire life cycle of the product[8].

In order to ensure food safety and improve the effectiveness of food safety control, the key sampling used for evaluating risk situations in sampling work should be based on the principle of being able to collect the samples with the highest risk. In actual sampling work, the samples with the highest risk should be collected as much as possible. If it cannot be achieved due to production processes, the samples with the second highest risk should be collected, and so on[2]. Specific details could refer to Table 1.

4 Main problems and countermeasures for sampling in food enterprises

Many food companies have increased their investment in product testing in order to improve their food safety control level. However, there are often some shortcomings in sampling, resulting in unsatisfactory results despite investing a lot of resources.

4.1 Scientifically setting sampling points Many enterprises require inspection of each batch of products in their inspection plans, which also poses a series of hidden dangers. The representativeness of the collected samples for testing is insufficient, and it cannot fully represent the quality of the entire batch of products. Although the sample testing results are qualified, there are individual products in the entire batch that do not meet the requirements of national standards. Therefore, regulatory authorities may discover and notify them during the sales process. Enterprises must analyze the characteristics of each testing project and combine the status of production processes to identify the samples with the highest risk and the most representative samples for testing, in order to effectively achieve the expected results in terminal inspection.

Table 1 Selection and formulation of sampling plans in different situations

Different situations	Sampling type	Physical and chemical projects	Microbial project
Daily release of finished products	Probability sampling; importance sampling	Paying attention to startup samples, shutdown samples, and tank change samples	Startup sample, shutdown sample, and change abnormal sample. Usually, whole batches of samples require systematic sampling for testing
Quality accident investigation	Importance sampling; snowball sampling	Expanding sampling at the time of accident occurrence, strict sampling of multiple consecutive batches of samples, and following up on the improvement of quality accidents	Expanding sampling at the time of accident occurrence, strict sampling of multiple consecutive batches of samples, and following up on the improvement of quality accidents
New production line	Importance sampling; systematic sampling	Paying attention to covering all projects and checking whether the results of the advent sample meet the standard requirements	Paying attention to covering all projects and paying attention to the proliferation of microorganisms

4.2 Overcoming the problem of insufficient representativeness of sampling time points The physical and chemical indicators of the samples are relatively stable after startup and before shutdown, but the microbial indicators need to focus on testing in addition to startup samples, shutdown samples, and system sampling according to the specific situation of the production line, such as samples after production line fault repair.

4.3 Standardizing the application of environmental sample sampling The control of microbial projects is relatively difficult, and the control points cannot be limited to the production line. Controlling the production environment is also an important way[8]. This requires standardizing the method of applying microbial samples, training operators, and being able to truly apply to contaminated areas and sanitary dead corners, rather than randomly selecting points for application work[9].

4.4 Strengthening the control of microbial risks In general, there is a sterilization stage in the production process of food, so the microbial risk is not high before the sterilization stage. Some products add other auxiliary materials after sterilization of the materials, such as soy sauce. The auxiliary materials added afterwards do not undergo sterilization processes, so once the microbial indicators are not qualified, it will cause high food safety hazards to the microbial control of the entire batch of products. Therefore, it is necessary to strengthen the control of microbial risks for the added materials, to avoid problems with the entire batch of products caused by some materials being substandard.

4.5 Paying attention to the transportation and preservation of samples

4.5.1 Non commercial sterile samples. The transportation and preservation of samples are also important in food testing. Some non commercial sterile products have high temperature requirements. If they are not stored according to the product's storage temperature, it can lead to a large number of microbial proliferation in the sample in the short term, resulting in unrepresentative test results. The transportation and preservation of samples are key steps to ensure that the results of microbial indicator testing can objectively and truly reflect the level of microorganisms in the sample[10]. It is necessary to equip a sampling box that can be sealed and insulated for sample transportation, and store the sample in the refrigerator or freezer as soon as possible[11].

4.5.2 Commercial sterile samples. Commercial sterile products need to be stored at 37 ℃ for several days according to the standard. Generally, enterprises have insulation rooms, and it is important to note that the temperature of the insulation room may affect the results of commercial sterilization. In general, commercial sterile samples have a longer shelf life. Once they enter the circulation process, and the microbiological project is not qualified, it may lead to food safety risks such as swelling or damaging the packaging, causing great harm to the brand of the enterprise. Therefore, enterprises need to pay special attention to it[12].

5 Conclusions

Quality is the lifeline to ensure the development of the food industry. Currently, the development of economic globalization has promoted the continuous development of various fields in China. Food enterprises are facing increasingly complex and ever-changing external environments, and enterprises have also increased their investment in inspection resources. Therefore, it is even more necessary to fully study sampling methods and process points[13], scientifically and reasonably collect high-risk and representative samples[14], fully utilize the invested inspection resources, in order to discover food safety hazards and improve product quality[15-16].

References

[1] TIAN Y. Explore the current situation, causes and countermeasures of food safety problems in China[J]. Modern Food, 2023(2): 167-169. (in Chinese).
[2] Milk and milk products: Guidance on sampling (ISO 707:2008)[S].

2009.
[3] IX-ISO. Sampling procedures for inspection by attributes—Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection (ISO 2859-1:1999)[S]. 1999.
[4] HU SS. Nutrition and health management and food safety in the context of big data[J]. Modern Food, 2023(2): 155 – 157. (in Chinese).
[5] General principles of CAC sampling (CAC/GL 50-2004)[S]. (in Chinese).
[6] Sampling procedures for inspection by attributes—Part 0: Introduction to the ISO 2859 attribute sampling system (ISO 2859-0: 1995)[S]. 1995. (in Chinese).
[7] ZHU JM. Analysis of cleaning technology for food processing equipment [J]. The Journal of New Industrialization, 2020(11): 59 – 61. (in Chinese).
[8] LI RS, LIU HM. Legal regulation of near-expired food safety issues under the background of social co-governance[J]. Storage and Process, 2023, 23(1): 70 – 74. (in Chinese).
[9] MIAO W, WU SQ, KONG FC. Analysis and control measures of microbial contamination in food processing environment[J]. Meat Industry, 2022 (4): 40 – 45. (in Chinese).
[10] ZHANG YZ, LIANG Q, LIU JQ. Discussion on the requirements and operating standards for sterile sampling of food[J]. China Food Safety Magazine, 2021(22): 45 – 46. (in Chinese).
[11] AN BZ. Discussion on the collection and preservation of food microbial testing samples[J]. China Healthcare & Nutrition, 2020, 30(21): 10. (in Chinese).
[12] PAN L, ZHANG Y. Study on risk management of food sample collection and storage[J]. China Food Safety Magazine, 2023(1): 79 – 81. (in Chinese).
[13] MING SX, WU YJ, YU YY, *et al.* Notes for sample management in food inspection[J]. Journal of Food Safety & Quality, 2019, 10(16): 5239 – 5244. (in Chinese).
[14] LIU Y, YANG L, XU AM. Exploration on common problems and countermeasures in food inspection sample management[J]. China Food Safety Magazine, 2023(6): 25 – 27. (in Chinese).
[15] CHAI XC, CHAI XY, ZHANG T. Problems and optimization measures in sample management process in food testing[J]. China Food Safety Magazine, 2023(4): 54 – 56. (in Chinese).
[16] YANG M, HU WB, LI YL, *et al.* Common problems and suggestions of sample receiving in food safety sampling inspection[J]. Modern Food, 2021(7): 143 – 145. (in Chinese).

(From page 48)

[21] LI YX, DAI ZY, DING SJ. Impact of rural industry convergence on rural household income: PSM analysis based on survey of 345 rural households[J]. Journal of Huazhong Agricultural University (Social Sciences Edition), 2017(4): 37 – 44, 146 – 147. (in Chinese).
[22] YANG ZS. Science of Land Resources[M]. Beijing: Economic Management Press, 2021. (in Chinese).
[23] YANG ZS, YANG SQ, YANG RY, *et al.* Classification method of land resources based on land use perspective[J]. Resources Science, 2021, 43(11): 2173 – 2191. (in Chinese).
[24] CHEN MQ, JIANG RK, ZHU MY, *et al.* Policy options of rural industrial land use in rural revitalization: Based on "the symposium on rural revitalization and rural industrial land use policy innovation"[J]. China Land Science, 2018, 32(7): 90 – 96. (in Chinese).
[25] BIN Y, ZHAN Q, WANG B, *et al.* Allocation efficiency, influencing factors and optimization path of rural land resources: A case study in fang county of Hubei Province, China[J]. International Journal of Environmental Research and Public Health, 2020, 17(16): 5898.
[26] HE LB, TANG G. Rural industry revitalization, farmland circulation and resource allocation efficiency: Based on the survey data of farmers in Hunan Province[J]. Jiangsu Agricultural Sciences, 2022, 50(7): 234 – 241. (in Chinese).
[27] ZHU PJ, WANG N, ZHANG Y, *et al.* Approaches of rural spatial planning and governance under the land spatial planning system: A case study of four typical villages[J]. Economic Geography, 2021, 41(4): 201 – 211. (in Chinese).
[28] WANG L, LIU HY. The idea of comprehensive land improvement in the whole region from the perspective of rural revitalization[J]. Rural Science and Technology, 2022, 13(11): 129 – 132. (in Chinese).
[29] LONG HL, CHEN KQ. Urban-rural integrated development and land use transitions: A perspective of land system science[J]. Acta Geographica Sinica, 2021, 76(2): 295 – 309. (in Chinese).
[30] Chongqing Wanzhou District Statistics Bureau. 2021 National Economic and Social Development Statistical Bulletin of Wanzhou District of Chongqing. [EB/OL]. http://www.wz.gov.cn/bmjz_89642/bm/tjj/zwgk_94960/fdzdgknr_94962/tjxx/sjfb/tjgb/202204/t20220401_10582181.html. (in Chinese).
[31] General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, Standardization Administration of China. National Standard of the People's Republic of China (GB/T 21010 – 2017): Current Land Use Classification[S]. Beijing: China Standard Press, 2017. (in Chinese).
[32] YANG RY, ZHONG CB. Land suitability evaluation of sorghum planting in Luquan County of Jinsha River dry and hot valley based on the perspective of sustainable development of characteristic poverty alleviation industry[J]. Agriculture, 2022, 12(11): 1 – 23.
[33] ZHANG L, PI J, LIU H, *et al.* Example analysis on the model of science and technology supporting rural industry development in Wanzhou District, Chongqing[J]. South China Agriculture, 2022, 16(7): 50 – 56. (in Chinese).
[34] GUO J, ZHANG XR, KONG XZ. The convergence of primary, secondary and tertiary industries and farmers' income generation: One case study of convergence of primary, secondary and tertiary industries in rural areas of Henan Province[J]. Issues in Agricultural Economy, 2019 (3): 135 – 144. (in Chinese).
[35] LIN J, SUN ST, LIU FS. Progress review on land science research in 2021 and prospects for 2022: The sub-report on land resources, land use and spatial planning[J]. China Land Science, 2022, 36(3): 116 – 126. (in Chinese).
[36] DONG ZJ, WEI YY, REN CH, *et al.* Comprehensive land improvement innovation for rural revitalization: Public value creation and realization[J]. Resources Science, 2022, 44(7): 1305 – 1315. (in Chinese).
[37] LIAO HF, WANG FZ, GAO L. Research review and prospect of the implementation path of rural industry revitalization in China[J]. Journal of Technical Economics & Management, 2021(11): 112 – 115. (in Chinese).
[38] TANG XW. Current situation and countermeasures of rural land resource utilization[J]. Agricultural Science-Technology and Information, 2022 (15): 32 – 34. (in Chinese).
[39] JU G, XIONG JY, WANG YM. Chongqing's practice of land element security to empower rural revitalization[J]. China Land, 2022(12): 16 – 18. (in Chinese).
[40] ZENG C, LIU PL, ZUO YL, *et al.* Research on rural revitalization path from the perspective of settlement "double repair": Taking Shajing village in Qidong county as an example[J]. Journal of Natural Resources, 2022, 37(8): 2018 – 2032. (in Chinese).