Master of Public Health

Integrative Learning Experience

An exploration of International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 17025 quality management in the Kansas Department of Agriculture Laboratory, and Food and Drug Administration (FDA) certification for a dairy analysis in a central laboratory

by
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MASTER OF PUBLIC HEALTH

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Abstract

ISO 17025 is the quality standard for testing and calibration laboratories. Food safety and quality management are implemented by good laboratory testing of food for microorganisms such as *Escherichia coli* and *Salmonella*. Food products can be a source of harmful biological and chemical factors for humans. During my applied practice experience at the KDA laboratory, I was involved in activities related to food safety, including identifying the results for dairy products and data analysis for public health improvement. It was found that the laboratory had monitored, controlled, and recorded environmental conditions in accordance with relevant specifications, methods, procedures, or instances where those conditions influence the validity of the results.

Chapter 1

An Overview of the History and Food Safety Relevance of ISO 17025

The Kansas Department of Agriculture Agricultural Laboratory (KDAL) is a department of the government of Kansas under the governor of Kansas. The lab relocated from Topeka to Manhattan in March 2020. The purpose of the KDA Laboratory is twofold: to help maintain and improve food safety and consumer protection and to support inspections that rely on scientific analysis to identify problems in food products. The KDA Laboratory has 50 agricultural testing methods on its International Organization for Standardization (ISO 17025) scope of accreditation. The ISO is a worldwide federation of national-standards bodies that uses technical committees to prepare international standards. ISO standards require testing and calibration laboratories to establish management systems to help ensure the acquisition of consistent and reliable laboratory data. The KDA Laboratory performs different tests for dairy, meat, feed, fertilizer, and pesticides. The lab performs microbiological, chemical, and metrological testing. The microbiology lab has a dairy testing area with biosafety Level 2 protocols. The chemistry lab has feed and fertilizer testing for animals, pesticide analysis, and hemp testing. The metrology laboratory provides accurate and reliable measurements to ensure KDA Laboratories maintains legal weights and measures. All weights and balances must be calibrated and traceable to recognized national or international calibration units. Accrediting bodies may require initial calibration by an ISO 17025 accredited calibration laboratory. The mission of the lab is to develop and protect human and animal health by ensuring that all data generated and processed is appropriate for its intended use, is scientifically valid, is of known precision and accuracy, is acceptably complete, and is legally defensible (Kansas Department of Agriculture Laboratory, 2016).

Countries with internationally recognized accredited laboratories have a significant advantage because of the quality standards their processes and products must meet and the removal of technical barriers to trade (Caten et at., 2017). Accreditation offers many benefits to the current landscape of laboratories in the United States through improved quality of testing, increased customer confidence, and access to new markets. International agreements, such as the International Laboratory Accreditation Cooperation Mutual Recognition Arrangement, were put in place to establish acceptable comparable parameters worldwide (Caten et at., 2017). From this agreement's implementation in 2000 until April 2016, laboratory accreditation has increased worldwide. The 50,000 accredited laboratories worldwide provide significant laboratory test results using ISO 17025, which improves lab quality outcomes, food safety, and human and animal health. There is a relationship between the total number of accredited laboratories and a country's gross domestic product (GPD; see Table 1.1 and Figure 1.1). The GPD is the total market value of all final goods and services produced within a country in each period. In most countries, there are more laboratories than institutions because some institutions have more than one accredited laboratory (Caten et at., 2017).

Accredited institutions and laboratories are those that have met certain standards and requirements, usually set by independent accrediting bodies, and have been certified as providing accurate and reliable services. The number of accredited institutions and laboratories is an indicator of a country's ability to provide quality services in various fields, such as food safety, and environmental protection. The GDP of a country is a measure of the total value of goods and services produced by that country each year. It is possible that countries with higher GDPs may have more resources to invest in developing and accrediting their institutions and laboratories.

Table 1.1 *Number of Accredited Institutions and Laboratories and Gross Domestic Product (GDP of 2014) per Country.*

Region of America	Country	Number of institutions with accredited laboratories	Number of accredited laboratories	GDP (109 US$)
North	Canada Mexico USA	299 911 3339	476 1254 4665	1785 1294 17419
Central	Costa Rica Cuba El Salvador Guatemala Jamaica Nicaragua	76 50 22 28 8 12	97 71 26 28 10 12	49 77 25 58 13 11
South	Argentina Brazil Chile Colombia Ecuador Paraguay Peru Uruguay	131 890 209 222 93 20 77 27	175 1167 309 312 118 28 78 31	537 2416 258 377 100 30 202 57

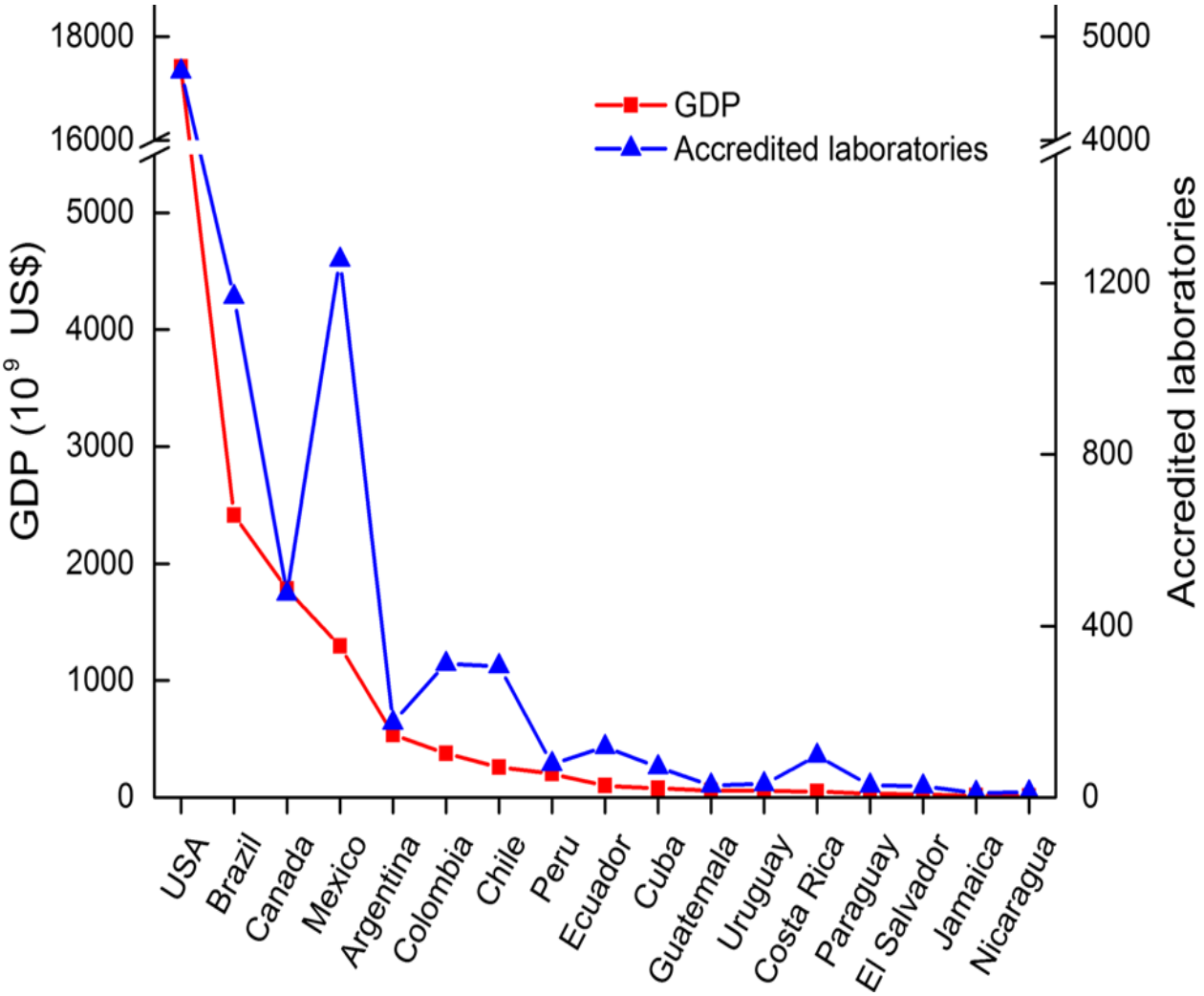

Figure 1.1 *Number of Total Accredited Laboratories and GDP per Country*

The countries with higher GPD tend to have a greater number of accredited laboratories. The graph displays the relationship between the total number of accredited laboratories and the GDP per country. It shows a generally positive correlation between the two variables, with countries with higher GDPs tending to have more accredited laboratories. The graph can be used to compare the number of accredited laboratories and GDP across different countries and to

identify any outliers or unusual patterns in the data. total number of accredited laboratories and GDP for each country.

Food safety and quality management are implemented by good laboratory testing of food for microorganisms such as *E. coli* and *Salmonella*. Food products can be a source of harmful biological and chemical factors for humans. The International Food Safety Authorities Network (INFOSAN), established under the World Health Organization (WHO), monitors global outbreaks and food safety recalls due to foodborne pathogens (Singh et at., 2023). *Salmonella*, Enterohemorrhagic *E. coli*, and *Campylobacter* are the most common bacteria that cause foodborne illness. The standards set by ISO 17025 accreditation improves laboratory food testing performance. Laboratory participation in proficiency testing to assess competency in analytical skills is mandatory per ISO 17025 for all accredited laboratories. Proficiency tests enable laboratories to evaluate and improve performance and quality control of the lab by maintaining the accreditation requirements. The authors suggest that the development of proficiency testing samples should consider the behavior of *Salmonella* species and pathogenic *E. coli* in food matrices. Continuous monitoring, improvement of laboratory processes, and development of proficiency testing samples are important to ensure the safety of the food product and reduce the foodborne illnesses (Singh et at., 2023).

Metrology improves laboratory production performance and increases the confidence level of a data report. Accredited laboratories use ISO accredited calibration for all lab tests because ISO 17025 provides detailed parameters for metrological traceability references material. Metrological tools in an ISO 17025 accreditation are important for evaluating the quality system of a biological evaluation facility. They use the tools to ensure accurate and reliable measurement in the facility including reference material, measurement uncertainty, and

proficiency testing. Metrology traceability establishes a direct link between the result of measurement made in the laboratory and the result of the best possible measurement made at a calibration facility (Joseph et al., 2022). Proper documentation and training in the use of metrological tools are necessary in order to maintain accreditation and ensure high quality results. Metrologies provide accurate measurement in laboratory testing for the food industry.

Validation guidelines (for example, from Eurachem) for chemical analysis have been developed to simplify and standardize method validation and to help testing and calibration laboratories improve their quality assurance and apply for accreditation according to the ISO/IEC 17025 standard (Hedman et at., 2018). The Polymerase Chain Reaction (PCR) is used to amplify specific DNA fragments and detect microorganisms in food that cause human illnesses. A specific application is the need for urgent validation in the event of a crisis such as a foodborne outbreak (Hedman et at., 2018). To ensure food safety, it is important to detect the foodborne pathogen quickly and accurately because of the serious public threat they cause. Identifying the specific microorganisms and the source of the outbreak is important to stop the outbreak. The performance of ISO methods should be verified at the laboratory when PCR is used to quickly detect foodborne pathogens in food. One such example is the interlaboratory validation of the ISO method for detection and enumeration of *Campylobacter* (Hedman et at., 2018). The procedure was intended to look for *Campylobacter* in a food sample. In addition, the liquid chromatography-mass spectrometry study of the heat degradation of veterinary antibiotics in raw milk after boiling describes a study that investigates the degradation of veterinary antibiotics in raw milk after boiling using LC-MS analysis. The study found that boiling raw milk can cause the degradation of certain veterinary antibiotics, which may have an implication for food safety and public health (Hedman et at., 2018).

One concern regarding food safety is zoonosis, the transmission of diseases from animals to humans, because it is one of the main barriers to the international trade of animal products. Considering the relevance of zoonoses to international trade, it is vital to ensure the quality of the critical analytical data generated by veterinary diagnostic laboratories (Camargo et al., 2017). These data are used in animal health control and monitoring programs (Camargo et al., 2017). The trustworthiness of a laboratory and its data quality are key to ensure the ongoing operation and safety of trade, which is where ISO/IEC requirements for laboratory testing and calibration come in to play. The ISO/IEC 17025 standard in laboratory testing helps increase efficiency and traceability in animal food products. These standards are an effective instrument to remove technical barriers and form a basis of mutual acceptance among counties, avoiding the duplication of tests and reducing the waste of time and resources. The accreditation process provides a framework for continuous improvement and highlights areas where laboratories need to improve.

Below, I provide several pictures from my work at the Kansa Department of Agriculture (KDAL)

Figure 1.2 APE site

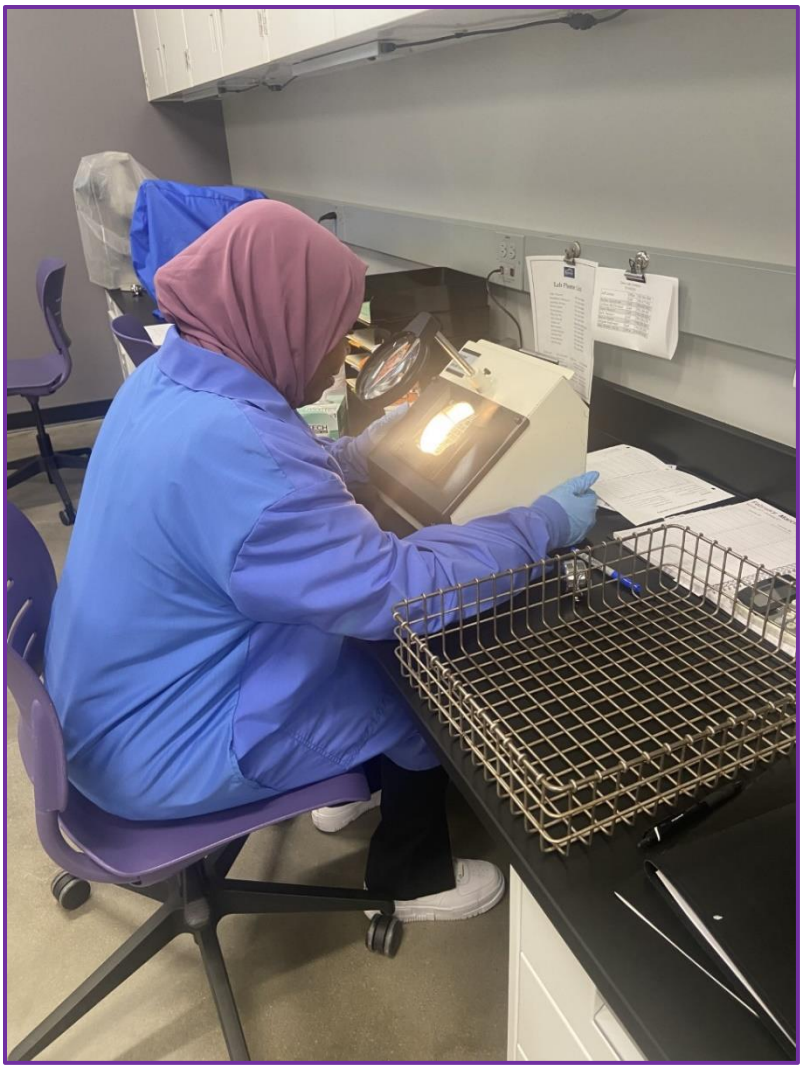

Figure 1.3 (Microbiology Lab, participate in coliform plate count (CPC))

Figure 1.4 Microbiology Lab

Figure 1.5 **Microbiology lab's butterfat machine**

Chapter 2

Summary of the Portfolio Products

During my applied practice experience (APE) at the KDA Laboratory, I was involved in activities related to food safety, including identifying the test results for dairy products and data analysis for public health improvement. I used calibrated instrumentation to provide traceable results. I learned the principles of laboratory system management (ISO 17025) related to public health issues. Additionally, I did the following:

- Attended weekly lab team meetings,
- Assisted with the sampling and preparation of chemistry extraction in the animal feed laboratory,
- Stored the samples under specified environmental conditions,
- Updated certain lab procedures for pesticides testing, and
- Helped with preparation of microbiology media.

Every batch of media should be examined to ensure it is suitable for use and it should undergo quality control verification. I conducted multiple dairy tests to help improve laboratory productivity and used PCR methods for automated pathogen detection. Overall, I had the pleasure of working 10 weeks with the KDA Laboratory staff. I used this time to explore specific MPH core competencies while I engaged in the creation of seven different outputs or products.

I worked with a microbiology lab testing team for testing raw milk following Food and Drug Administration (FDA) guidelines (Food and Drug Admistration,2017). We used samples collected from individual dairy producers. I performed a swab method for pasteurized milk containers following FDA guidelines. The procedure described the method for enumerating

aerobic bacteria and coliforms present in a single service container to assure that bacteria counts do not exceed federal regulations. It was applied to nonintact products to verify that the containers were produced under sanitary conditions and would not contaminate the pasteurized dairy product.

The procedure steps included swabbing the samples, placing the swabs in nutrient broth and shaking them, plating the nutrient broth, incubating the plates, and counting and reporting the colonies. I sanitized the plating area with Lysol disinfectant spray, labeled two plates with the lab number for each sample, and set up the control plate. I poured 10 ml to 12 ml of Standard Plate Count Agar (SPCA) into the plate and swirled to completely to cover the bottom of the plate. Using a timer, the sample sat uncovered for 15 minutes; the lid was replaced after 15 minutes. I dispensed 5 ml of nutrient broth (NB) into a sterile test tube and left the swab in the tube. For each bottle of SPCA used on samples, I poured 10 ml to 12 ml of agar from the bottle onto a plate labeled with sample numbers. Counter swab testing was done once a day. I moistened a sterile swab in a 5 ml tube of NB. I swabbed a small area of the counter and returned the swab to the tube. I shook the tube by striking it against my palm 50 times in approximately 10 seconds. I plated 1 ml into a petri dish, poured 10 ml to 12 ml of SPCA, and swirled to mix. All samples were to remain at room temperature before and during testing. When swabbing the film, I avoided swabbing near the edge of the film and paid attention to how the file was wound to ensure the food-contact side was swabbed. I counted the colonies that were formed using automated colony counters to verify accuracy against a manual count. If the plate could not be counted immediately, it may be stored at 0.0°C to 4.5°C for up to 24 hours. Upon completion, I discarded all contents of the plates and culture tubes used in the biohazardous waste and

autoclaved the equipment. All samples were to be treated as if they contained bacteria and antibiotic residue; therefore, I wore personal protective equipment (PPE).

I completed 20 online modules at the KDA Laboratory using its Qualtrax document management system to study how ISO 17025 is an important standard for testing and calibration laboratories. The supervisor tracked the training and administrative staff-maintained training records. The training included online courses or modules through a KDA Laboratory. One module that I completed online covered the method for alkaline phosphatase detection, which was used to verify that the heat of pasteurization was done correctly. Alkaline phosphatase is an enzyme that is present naturally in milk and can be destroyed at a temperature near pasteurization. In another module, I did a Charm quantitative test for aflatoxin in raw milk. I also did a butter fats test online to determine the amount of fat in finished dairy products. Additional modules covered calibration, verification, maintenance of critical equipment, chemical suability, corrective/preventive action, documents control, ethics statement, environmental conditions, internal audit, management review, method development, validation and verification, hazard waste, good housekeeping, measurement of uncertainty in chemistry, nonconforming work, procedures for receipt and handling of feed and fertilizer sample, report test results, solution and reagent preparation, purchasing chemicals and supplies, traceability, verification of balances, and verification of working times. I passed all the training modules online and Dr. Flowers maintained records of my passing results.

I conducted a procedure for determining the presence of tylosin—an antibacterial antibiotic—in animal feeds at the KDA Laboratory. I sampled and weighed 20 g of animal feed into a 250 ml Erlenmeyer flask and extracted it with acidified methanol. Samples were sonicated for 20 minutes and then transferred to a mechanical shaker for 1 hour. The sample was centrifuged

and diluted, as necessary, before passing through a filter and injected with a liquid chromatography and mass spectrometry. A chromatographic system was used to detect responses for the analytical methods. The method was performed under the hood, and I wore PPE to protect from skin burns that could be caused by hyaluronic acid. All reagents and sample waste were poured down into the drain with copious amounts of running water.

KDAL (presume a regulatory or veterinary agency) is likely concerned about tylosin in animal feed because it is an antibiotic commonly used in veterinary medicine to treat bacterial infection in livestock. However, when tylosin is used in animal feed, it can also promote growth and prevent diseases in the animals, leading to increased efficiency in animal production. The concern is that the use of tylosin in animal feed can lead to the development of antibiotic-resistant bacteria, which can pose a threat to both animal and human health. When these bacteria are transmitted to humans through consumption of contaminated animal products or environmental exposure, they can cause difficult to treat infections. Therefore, regulatory groups such as KDAL may be monitoring the use of tylosin in animal feed to ensure that it is being used safely and appropriately to minimize the risk of antibiotic resistance development and protect public health.

The management review/quality system summary report is an overview of the activities covering all portions of the quality management system. The assessment of the quality system addresses all aspects of the ISO 17025 general requirements. This is a cumulative report that is updated after each quarterly meeting. The actions of the review are reported on a KDA Laboratory document. The management review included a review of nonconforming work and customer and personal feedback and complaints. The KDA Laboratory reviewed its management system at planned intervals to ensure the continuing suitability and effectiveness of policies and objectives. Also, the KDA Laboratory reviewed the changes in internal and external issues relevant to the

laboratory including staffing, regulation, customer base, and industry trends. The changes or updates from the management review were recorded, including all decisions and actions related to improving laboratory activities and the effectiveness of the management system.

I attended the KDA Laboratory's annual ISO 17025 assessment with Dr. Flowers. An independent, third-party accreditation body performs annual assessments to verify whether the laboratory system is meeting all requirements. A third party evaluated the laboratory methods used to implement any corrective action needed. It also examined the calibration record and performance of any equipment used. Guidance was provided on the degree of validation required for method modifications during laboratory activities. The annual assessment helps the lab improve its ability to consistently produce valid, accurate results for the customers and the community.

During my experience, I created a total of 7 portfolio products; these are mentioned later in this ILE report (in chapter 4), and a detailed explanation of each portfolio product appears in chapter 1 of my APE report. (Unfortunately, I do not have copies of these products because I am not permitted to transport them out of KDAL, but they are available, if necessary, at KDAL.)

Chapter 3

Lessons Learned during my Applied Practice Experience

The KDA Laboratory had monitored, controlled, and recorded environmental conditions in accordance with relevant specifications, methods, procedures, or instances where those conditions influence the validity of the results. The laboratory practiced good housekeeping—ensuring benches, equipment, and floors were clean before and after preparation activities to help ensure testing integrity. Monitoring in a microbiology laboratory includes environmental swabbing, hand swabbing, air monitoring for bacteria and mold, water testing, temperature monitoring, and PCR amplicon swabbing. Monitoring in a chemistry laboratory includes temperature of the instrument room, humidity, room lighting, and water testing. In addition, the KDA Laboratory was establishing training on laboratory activities including the quality management system. This was beneficial because it ensured proper coverage for laboratory activities and facilitated employee development.

The KDA Laboratory maintains metrology traceability of its measurement results through a documented, unbroken chain of calibrations. Figure 3.1 shows a look at the metrology laboratory. The laboratory was assured that measurement results are traceable to the International System of Units (SI) through calibration provided by a competent laboratory. When metrological traceability to an SI unit is not technically possible, the laboratory demonstrated metrological traceability to an appropriate reference. All equipment requiring calibration, or that had a defined period of validity, shall be labeled, coded, or identified to allow the user of the equipment to readily identify the status of calibration or validity (see Figure 3.2).

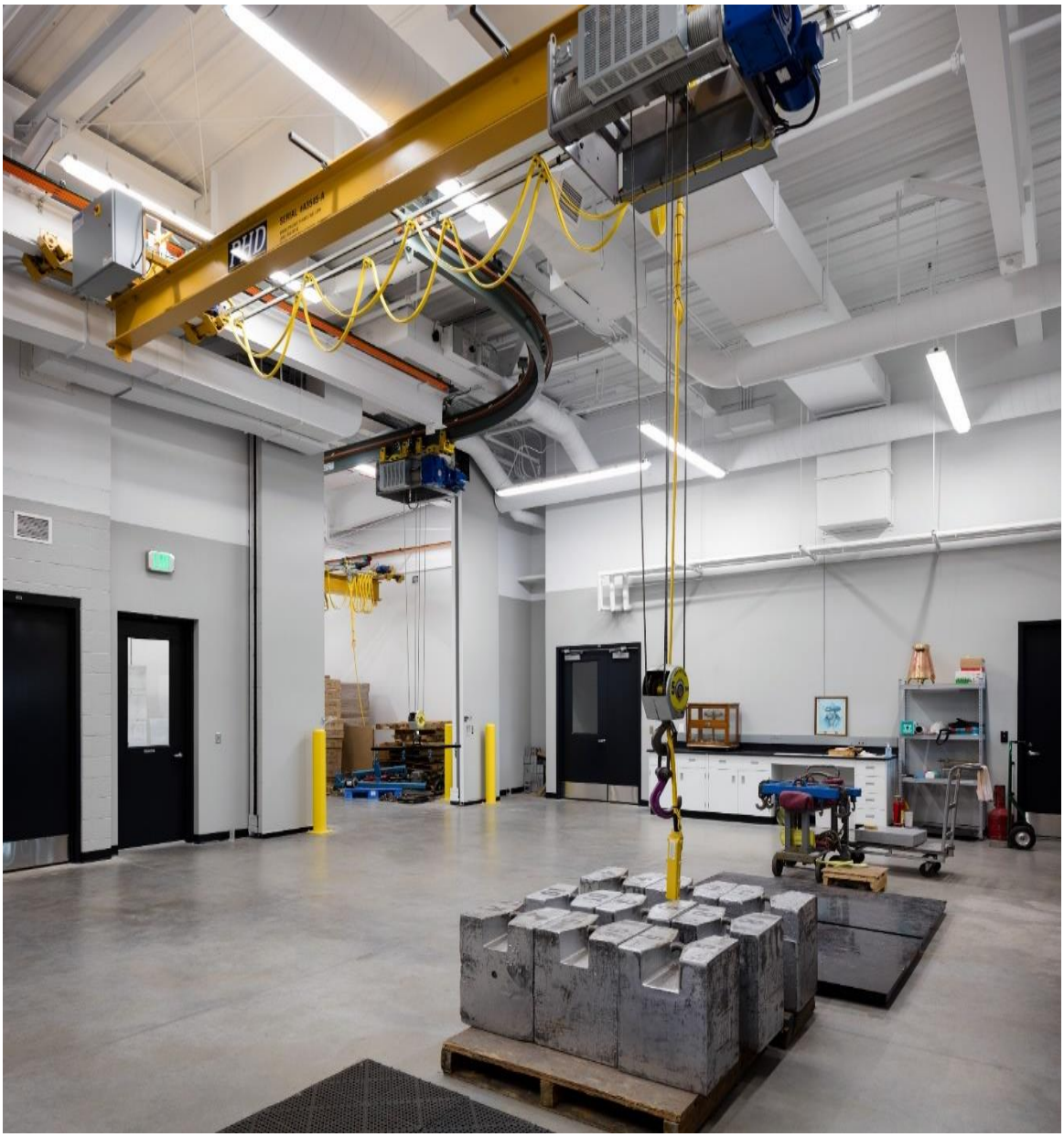

Figure 3.1 *Kansas Department of Agriculture Metrology Lab*

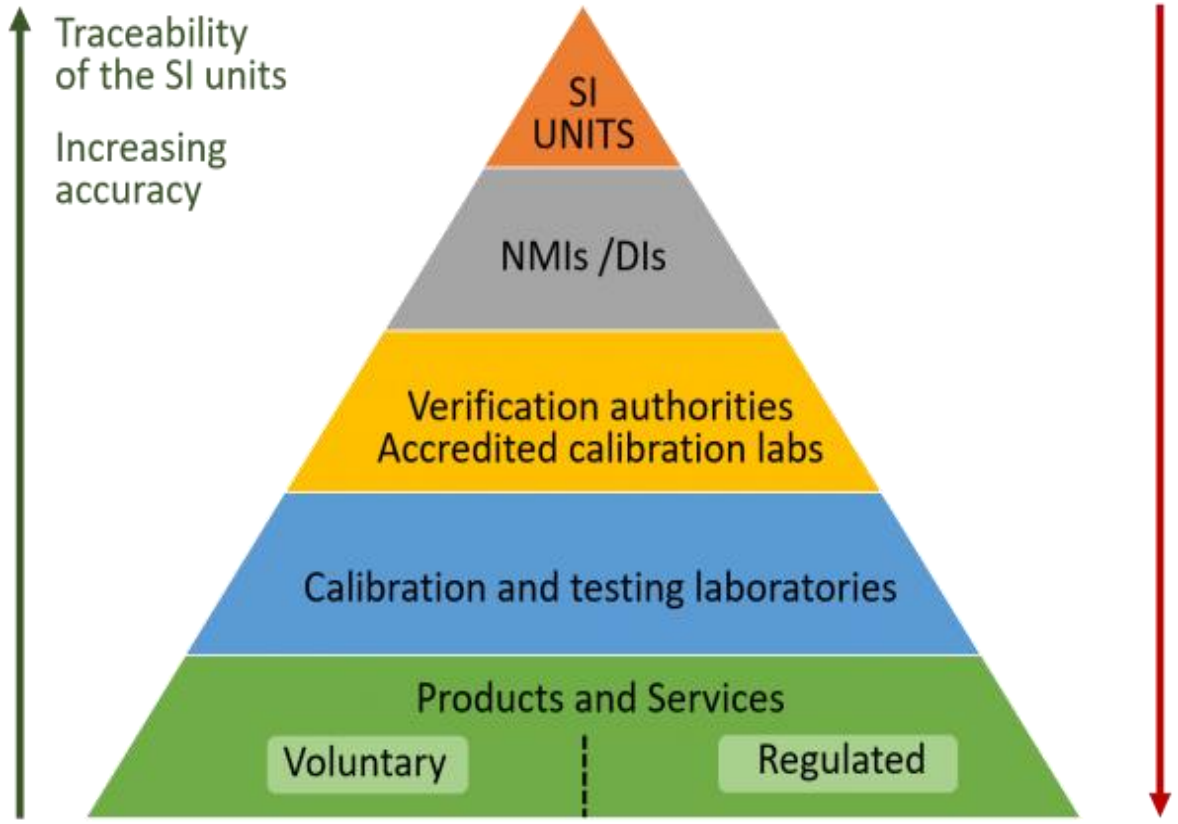

Figure 3.2 *Traceability of SI units used in laboratory settings.*

While at the KDA Laboratory, I learned about antibiotics in raw milk and tested raw milk three times for antibiotics. Antibiotics are used on many farms to treat mastitis infections. Cows under antibiotic treatment for mastitis infections may have antibiotic residues in their milk, so milk from treated cows was discarded and not sent to the factory. Antibiotic residues in milk exhibit high heat stability. I examined the somatic cell count (SCC) and standard plate counts (SPC) tests to determine milk quality and measure the white blood cells present in milk. The quality of raw milk was the primary factor determining the quality of milk products. I wore PPE specific to the type of testing being performed. Some of the microbes found in dairy products may be

pathogenic; therefore, thorough hand washing occurred after sample handling. All plates were discarded in biohazardous waste and autoclaved prior to discarding. Analysts must be FDA certified to perform raw milk testing. Certification is obtained by satisfactory performance during the annual FDA spilt sample analysis and during FDA on-site evaluation.

The KDA Laboratory handled complaints regarding any related issue. Upon receipt of a complaint, the laboratory should confirm whether the complaint relates to its specific laboratory activities or if the complaint should be sent elsewhere. For relevant complaints, the laboratory had a documented process to receive, evaluate, and decide on complaints. A description of the handling process for complaints is available upon request. The laboratory was responsible for all decisions at all levels of the handling process for complaints. The process for handling complaints included the description of the process for receiving, validating, and investigating the complaint, and deciding what actions were to be taken in response to it. Also, the laboratory that received the complaint was responsible for gathering and verifying all necessary information to validate the complaint, acknowledging receipt of the complaint, and providing the complainant with progress reports and the outcome. The outcomes to be communicated to the complainant shall be made by, or reviewed and approved by, individuals not involved in the original laboratory activities in question.

The quality assurance system for environmental monitoring, samples, and measurement activities included a quality management plan and management system reviews. The quality management plan was described as a quality assurance system in terms of organization structure; policy and procedures of the management and staff; line of authority; and necessary interfaces for those conducting the planning, implementing, and assessing. The quality management plan was an essential component of the quality assurance system. In addition, I learned that a management

system review was a qualitative assessment of a data collection operation to establish whether the prevailing quality management structures and policies practices and procedures are adequate for ensuring that the type and quality of data needed were obtained. If appropriate, a management system review was conducted to ensure the quality assurance system was successfully implemented and identified opportunities for improvement. The program used internal and independent management system reviews as a check on the quality assurance system.

All levels of the KDA Laboratory program staff are accountable for continuous improvement, a process that led to a better and more responsive quality assurance system. To minimize, detect, and correct lab activity problems, the program has established an assessment approach to address quality assurance at both the program and project levels. Staff involved in day-to-day operations are encouraged to identify quality-assurance-related problems, issues, or opportunities for improvement and become involved in their resolution and implementation.

Chapter 4

Competencies and Reflection on Coursework

Table 4.1 *Summary of the MPH foundational competencies*

Number	Competencies	Description and example of product created
16	Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence	I worked closely with my preceptor Dr. Sally Flowers and discussed with her the policies and procedures appropriate and important for laboratory testing. I discussed how a standard ISO policy was a type of policy that was drafted by International Organization for Standardization (ISO 17025) to ensure the quality and safety of food product system. The laboratory had a policy for how and when manual processing and integrating of chromatographic data was appropriate. The laboratory was responsible through legally enforceable commitments for the management of all information obtained during the performance of laboratory activities. This competency was emphasized during portfolio product 6 (personal notes during 8-hour-long annual laboratory ISO 17025 assessment).

4	Interpret results of data analysis for public health research, policy, or practice	This competency was achieved during my creation of portfolio product 1 (personal journal notes from my work with a Food and Drug Administration certification for a dairy analysis in a central laboratory) and portfolio product 2 (personal journal notes from my engagement with CPC analysis of dairy samples).
12	Discuss multiple dimensions of the policy-making process, including the roles of ethics and evidence	This competency was achieved by completing the online education regarding laboratory system management (ISO 17025) related to public health (portfolio product 3).
21	Perform effectively on interprofessional lab teams	I worked with lab teams under Dr. Sally Flowers' supervision. I attended all lab meetings regularly during my APE. Portfolio products 6 and 4 illustrate this.
2	Select quantitative and qualitative data collection methods appropriate for a given public health context	This competency was achieved by collecting data (specifically during portfolio products 5 and 7).

Table 4.2 *Summary of MPH emphasis area competencies (Food Safety and Biosecurity)*

Number	Competency	Description
1	Food safety and biosecurity	Evaluate solutions appropriate for different food

		safety, biosecurity, and defense issues in the food production continuum.
2	Threats to the food system	Examine specific threats to the food system and scientifically investigate how each can be prevented, controlled, and/or mitigated in the food production system
3	Food safety laws and regulations	Differentiate key U.S. food safety regulatory bodies and their unique legislative authorities, missions, and jurisdictions
4	Food safety policy and the global food system	Analyze and distinguish how food safety and governmental biosecurity policies, globalization, and international trade cooperation influence public health
5	Multidisciplinary leadership	Contrast the food safety and biosecurity technical needs of different stakeholders and make judgments as to the

		appropriate as to the appropriate methods of collaboration

I achieved food safety and biosecurity (FSB) competency #1 during my internship with KDA Laboratories. I was tasked with swab methods for pasteurized milk containers; this procedure is applicable to nonintact products to verify the containers are produced under sanitary conditions so as not to contaminate the pasteurized dairy products. For FSB competency #2, I tested raw milk three times for antibiotics. Antibiotics are used on many farms to treat mastitis infection. Cows under antibiotic treatment for mastitis infection may have antibiotic residues in their milk. I also examined the somatic cell count (SCC), standard plate count (SPC) tests to determine milk quality and measure the white blood cells present in milk. The quality of raw milk was the primary factor determining the quality of milk products. For FSB competency #3, I learned about the procedures for obtaining FDA certification for a dairy analysis in a central laboratory. The certification of dairy (milk) laboratory analysis by the FDA was followed by the evaluation of the state central milk laboratory. The process to become a certified milk laboratory analyst usually takes 1 year or more. The Food and Drug Administration requires testing for dairy (milk) by an FDA-certified analyzer to demonstrate satisfactory compliance of the milk laboratory and to improve the safety of the U.S. dairy supply. For FSB competency #4, I attended the lab's annual ISO 17025 assessment. This involved an independent, third-party accreditation body performing an annual assessment to verify whether the KDA Laboratory is meeting all the requirements. It happens every year. During this process, I learned about how the principles of laboratory system management by ISO 17025 are relevant to public health. Finally, for FSB competency #5, I learned how Dr Flowers goes about her management reviews. This

effort involves addressing all portions of the quality management system such as changes in internal/external issues, volume of work, and customers' feedback, and complaints relevant to the laboratory.

Reflection on MPH coursework

I took five courses during my MPH program that particularly helped me prepare for my field experience work at the KDAL. I took the MPH 802 Environmental Health course which helped me in laboratory testing by understanding environmental contaminants and identify which contaminants to test for and how to detect them. MPH 802 provided me with knowledge and skills necessary to perform laboratory testing related to environmental health. By understanding environmental contaminants, learning laboratory techniques, identifying health effect, and develop critical thinking skill I can become proficient in laboratory testing and make significant contributions to the field of Enviromental Health Science. In addition, the FDSCI 730 A Multidisciplinary Overview of Food Safety and Security course provided me with knowledge and skills necessary to conduct laboratory testing for food safety purposes. This course gave me a background to better understand the identification of food borne pathogens, testing methods, good laboratory practice, risk assessment, and regulatory requirements, and at the KDAL, I gained experience in laboratory testing for food safety. In addition, I took FDSCI 731 Food Protection and Defense – Essential Concepts that helped me understand that laboratory testing must be conducted accurately and reliably to safeguard public health and the safety of food products. The MPH 754 Introduction to Epidemiology course helped me understand the

principles and methods used to investigate and control the spread of diseases. I benefitted from the principles and methods taught in Epidemiology, which provide me with a foundational understanding of disease transmission, data analysis, study design, and communication during laboratory testing for food safety.

Chapter 5

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