

Exploration of Teaching Reform of the "*Frontier Food Processing Technologies*" Course Based on the New Engineering Concept

Ting BAI, Rui FENG, Jie CHENG, Weijun CHEN, Xinhui WANG, Jiamin ZHANG *

Key Laboratory of Meat Processing of Sichuan Province/Sichuan Provincial Engineering Research Center of Meat Quality Improvement and Safety Control Technology, Food Processing and Application Key Laboratory of Universities in Sichuan Province, College of Food and Bioengineering, Chengdu University, Chengdu 610106, China

Abstract Frontier Food Processing Technologies is a core backbone course in the food science and engineering discipline. Guided by the core concepts of New Engineering—"interdisciplinary integration, innovation driving, and industrial adaptability", it integrates outcomes from multiple fields including biotechnology, intelligent equipment, green chemical engineering, and sensor-based detection, and focuses on four core objectives: efficient processing, nutrient preservation, safety control, and low-carbon production. Effective teaching of this course is crucial for cultivating interdisciplinary technical talents needed for the transformation and upgrading of the food industry, directly impacting students' technological application capability and workplace competitiveness. Under the New Engineering background, in response to issues in course teaching such as outdated textbooks, disconnection between theory and industry, and insufficient practical support, a systematic reform plan is proposed from aspects including teaching team construction, teaching content iteration, teaching system optimization, innovation and entrepreneurship ability cultivation, targeted talent development, and assessment mechanism innovation. This plan aims to promote the high-quality and sustainable development of the course and effectively enhance the effectiveness of talent cultivation.

Key words Frontier Food Processing Technologies; New engineering education; Teaching reform; Practice-based education; Industrial adaptability

DOI:10.19759/j.cnki.2164-4993.2026.04.013

Currently, the global technological revolution and industrial transformation are in a critical period of deep interweaving. Disruptive technological innovations represented by artificial intelligence, biotechnology, and new materials are reshaping the global economic structure and industrial landscape. Against this macro-background, the Ministry of Education, the Ministry of Industry and Information Technology, and other relevant departments have been continuously promoting the construction of "New Engineering" disciplines. They have successively issued documents such as the "Fudan Consensus", the "Tianjin Action", and *Opinions on Accelerating the Development of New Engineering and Implementing the Excellent Engineer Education and Training Plan 2.0*, proactively addressing the new challenges posed by the new round of technological revolution and industrial transformation to engineering talent cultivation^[1]. The core of New Engineering construction lies in promoting the close integration of modern science and technology with production practices through disciplinary integration. It drives the transformation of talent cultivation models from discipline-oriented approaches to industry-demand-oriented approaches by establishing new majors, restructuring existing ones, and

promoting cross-disciplinary integration, thereby providing strong talent support for technological innovation and industrial upgrading^[2-3]. This transformation of the educational paradigm not only signifies a breakthrough in the traditional engineering knowledge system, but also requires a fundamental shift at the curriculum level, from knowledge transmission to competency development, from single discipline to interdisciplinary integration, and from classroom-bound to industry-education collaborative approaches^[4]. The food industry is a vital pillar of the national economy and is currently undergoing a critical period of intelligent, green, and precise transformation. With the rapid industrial application of cutting-edge processing technologies such as ultra-high pressure processing, 3D printing, functional food development, and clean processing, as well as the deep integration of digital transformations, including the Internet of Things, big data, and intelligent equipment, into food production, processing, and distribution, the talent demand structure of the traditional food industry is undergoing profound changes^[5]. This transformation on the industry demand side compels universities to make adaptive adjustments to their curriculum systems in food majors.

Current Status and Problems of the "*Frontier Food Processing Technologies*" Course

As a core course in food science and engineering majors, "*Frontier Food Processing Technologies*" is characterized by rapid knowledge updates, strong interdisciplinary nature, and high practical demands. It is expected to play a central role in cultivating students' innovative thinking and engineering practice ability

Received: April 15, 2026 Accepted: June 20, 2026

Supported by Project of Higher Education Talent Cultivation Quality and Teaching Reform in Sichuan Province from 2024 to 2026 (JG2024-0924); Earmarked Fund for China Agriculture Research System (CARS-43).

Ting BAI (1989 –), female, P. R. China, PhD, senior experimentalist, devoted to research about food processing and safety.

* Corresponding author. Jiamin ZHANG (1982 –), female, professor, master, devoted to research about food processing and storage.

within the context of New Engineering construction. However, an examination of the current teaching status reveals numerous shortcomings that are incompatible with the New Engineering philosophy. In specific, the teaching content is predominantly a static introduction to technical principles, lacking timely responsiveness to cutting-edge industrial developments. The experimental and practical components largely remain at a confirmatory level, showing a clear disconnect from the actual demands of intelligent industrial upgrading. Moreover, the teaching model remains primarily lecture-centered, providing insufficient comprehensive training for students in interdisciplinary complex engineering problem-solving.

Therefore, based on the New Engineering construction philosophy of "adapting to changes and shaping the future", and guided by Outcome-Based Education (OBE), it is imperative to advance the teaching reform of the "*Frontier Food Processing Technologies*" course.

Teaching Reform Measures for the "*Frontier Food Processing Technologies*" Course

The core of this course reform lies in breaking through traditional disciplinary boundaries. Based on the "Five New" concept, the course has been repositioned within the interactive framework of "New Engineering-New Business Forms-New Technologies". Through explorations in teaching team development, teaching content, and teaching system reform, the course evaluation mechanism is innovated, the direction of talent cultivation is clarified, and the deep integration of the education chain, talent chain, and industrial chain is promoted.

Building a composite teaching team

In terms of teaching team development, disciplinary barriers should be broken down to form a composite team of "university teachers + industry experts + research core members". Led by senior professors in the food processing field, the team integrates faculty from food engineering, mechanical automation, bioengineering, materials science, and other relevant disciplines. By leveraging the advantages of experienced senior faculty in industry engagement and technical expertise, while also drawing on the innovative thinking and sensitivity to cutting-edge technologies of younger faculty, a tiered mentoring system bridging senior, middle-aged, and young faculty members has been established, thereby promoting the synergistic enhancement of the team's professional competence and teaching level^[6]. A regular teaching and research mechanism has been established, with interdisciplinary teaching seminars held monthly to transform frontier technology cases in food processing such as high-voltage pulsed electric field sterilization, microwave-assisted extraction, 3D food printing process optimization, and intelligent sensor-linked processing into concrete teaching resources, thereby enhancing the practicality and cutting-edge nature of the course^[7]. Diverse information channels are fully explored, including core industry journals, industry white papers, technical seminar proceedings, and professional new media platforms, to collect the latest research findings and

industrial application trends in processing technologies. These are integrated into the classroom in the form of technical flowcharts, process comparison data, and equipment operation videos, making abstract engineering knowledge more understandable and attractive. In teaching implementation, an interactive section is established on the online teaching platform, supplemented with technical extension materials, industry case analyses, and periodic assessments. Real industrial technical challenges are used as entry points to introduce teaching content, thereby strengthening teacher-student interaction and knowledge application, and promoting the deep integration of theoretical learning with industrial practice. This effectively enhances students' mastery and application ability of frontier processing technologies.

Iterative upgrading of teaching content

Traditional food processing courses have mostly focused on the instruction of classical processes and the explanation of basic principles. With the advancement of New Engineering construction and the technological iteration of the food industry, the limitations of traditional teaching have become increasingly apparent. As an emerging interdisciplinary course, "*Frontier Food Processing Technologies*" currently faces prominent problems such as outdated teaching materials (with a 3–5 year gap from industrial technologies), a disconnect between theory and production practice, and insufficient integration of interdisciplinary knowledge^[8]. This course covers a wide range of topics and undergoes rapid technological updates, occupying a central position in the training of professionals in food science and engineering, food quality and safety, agricultural product processing and storage, and related fields. This requires teaching to break free from the constraints of traditional textbooks, keep pace with technological frontiers, and achieve dual innovation in both teaching content and methods. To address these issues, instructors should deeply integrate New Engineering teaching concepts, and in light of the course's characteristics of "technology-intensiveness, strong practicality, and interdisciplinary integration", a blended teaching model of "online-offline linkage + case-driven + project-based inquiry" should be implemented. Through platforms such as Superstar Learning Platform and Rain Classroom, resources including frontier technology lecture videos, process solutions from leading industry enterprises, and equipment operation tutorials are regularly uploaded^[9]. In classroom teaching, the traditional "lecture-only" model is abandoned, and interactive formats such as case discussions, technical debates, and group problem-solving are adopted. Assisted by virtual simulation (VR) for complex processing scenarios and online virtual laboratories, students are immersed in the technological application process, thereby stimulating their learning initiative and desire for exploration.

Improving the three-dimensional teaching system

Practical teaching is the core link in the cultivation of talents in frontier food processing technologies, directly determining the quality of talent cultivation. Under the New Engineering background, interdisciplinary knowledge integration, innovative

thinking cultivation, and practical ability enhancement are essential requirements of course teaching. Interdisciplinary integration requires students to possess the ability to apply knowledge from multiple fields in a coordinated manner. Innovative thinking requires students to propose process optimization or equipment improvement solutions based on technological frontiers. Practical ability requires students to transform theoretical knowledge into actual production operations and solve technical problems at the industrial frontline^[10]. Based on this, a four-level "theory-simulation-practice-innovation" teaching system should be constructed, incorporating new teaching methods such as project-driven and scenario-based inquiry approaches. The role of teachers as "guides + enablers" should be clarified, and the assessment and evaluation mechanism should be refined with a student-centered focus, thereby deeply implementing the OBE teaching philosophy^[11]. The specific reform can be advanced from five aspects. "Real processing projects" is used as the vehicle (*e.g.*, "Optimization of microwave freeze-drying process for fruits and vegetables", "Development of efficient extraction technologies for functional foods") to replace the traditional lecture-based teaching model, thereby enhancing students' teamwork and project execution capabilities. Course-based ideological and political education is organically integrated throughout the entire teaching process, strengthening students' awareness of quality and safety, craftsmanship spirit, and green production concepts, and stimulating intrinsic motivation for professional learning. Relying on the "Internet + Food Processing" model, resources such as inter-school shared courses, live lectures by industry experts, and virtual tours of enterprise production lines are introduced to broaden students' technical vision and industry awareness. A closed-loop interactive mechanism of "pre-class preview – in-class inquiry – post-class practice – feedback improvement" is improved to ensure deep teacher-student communication and timely assessment of students' knowledge application effectiveness. The synergistic integration of online virtual simulation experiments and offline physical laboratory operations is deepened, and a three-tier practical platform of "basic verification – comprehensive design – innovative R&D" is established, providing solid support for the "student-centered" teaching reform^[12].

Cultivating comprehensive innovation and entrepreneurship capabilities

High-quality development is the core orientation for universities in fulfilling the fundamental task of fostering virtue through education, and is also an inevitable requirement for the transformation and upgrading of the food industry. Driven by both the upgrading of consumer demand and industrial technological innovation, frontier food processing technologies show broad application prospects in areas such as functional food development, industrialization upgrades of traditional foods, and green and low-carbon production. These developments place higher demands on students' professional foundation, comprehensive competence, and innovation ability^[13]. To strengthen students' innovation and

entrepreneurship capabilities, a mature competition system has been established both domestically and internationally, such as the "National College Students Food Innovation Competition" hosted by the Chinese Institute of Food Science and Technology, and the "Food Processing and Safety Innovative Design Competition" initiated by the Teaching Steering Committee of Food Science and Engineering Majors in Higher Education Institutions under the Ministry of Education. China's food processing industry ranks first globally in scale, and the abundant application scenarios of frontier technologies provide a fertile ground for cultivating innovation and entrepreneurship talents. On this basis, a dual-innovation training mode of "interest leading-competition empowerment-scientific research support" can be constructed^[14]. Relying on university research platforms, students are encouraged to participate in processing technology R&D projects led by faculty members, transforming laboratory outcomes into course practice topics. Students are organized to participate in innovation competitions at various levels, promoting learning and innovation through competition, and accumulating experience in project R&D and outcome translation. In collaboration with leading food enterprises, an "Innovation and Entrepreneurship Incubation Fund" is established to support students in implementing and translating outstanding technical proposals, cultivating their core abilities to independently identify, analyze, and solve problems, thereby achieving the training objective of "applying knowledge in practice and promoting action through innovation"^[15].

Clarifying the direction of talent cultivation

In recent years, the frontier food processing technology industry has shown rapid development. According to statistics, the global food and beverage processing equipment market was valued at approximately USD 85.19 billion in 2023 and is projected to reach USD 128.65 billion by 2030, with particularly fast growth in sub-sectors such as intelligent processing equipment, green processing technologies, and functional food processing. As a product of multidisciplinary integration, frontier food processing technologies have made breakthrough progress in fields such as deep processing of agricultural products, extraction of functional ingredients, personalized food customization, and low-carbon production processes^[16]. However, the industry still faces numerous challenges: the insufficient domestication rate of core processing equipment, long cycles for translating laboratory technologies into industrial production, high costs of low-carbon processing technologies, and a significant shortage of interdisciplinary technical talents, all of which constrain industry development. In response to these pain points, universities should accurately position their talent cultivation efforts. By integrating students' interests with industry needs, they should focus on cultivating three core competencies: interdisciplinary technology integration competency, equipment operation and process optimization competency, and innovative R&D and outcome translation competency. In addition to offering undergraduate and graduate-level courses, collaborative efforts involving universities, research institutes, and leading

enterprises should be coordinated to build a knowledge system characterized by "multidisciplinary intersection and upstream-downstream integration". University-enterprise joint training models should be deepened through the co-establishment of training bases, joint curriculum development, and on-campus teaching by enterprise mentors, thereby accelerating the supply of technical and applied talents and precisely matching industry demands.

Innovating the course assessment mechanism

The "Frontier Food Processing Technologies" course should comprehensively evaluate students' overall ability and stimulate active learning enthusiasm through diversified assessment methods and distinctive practical projects. Traditional assessments, which rely mainly on final examinations and lab reports, tend to focus on the memorization of theoretical knowledge and struggle to objectively measure students' technological application, innovative thinking, and teamwork ability^[17]. Therefore, a three-in-one assessment system comprising "process-oriented evaluation + summative evaluation + distinctive project evaluation" should be constructed. For example, process-oriented evaluation accounts for 50%, covering classroom interaction, project progress, practical operation, and industrial training performance. Summative evaluation accounts for 30%, and is conducted in the form of technical proposal design and oral defense. Distinctive project evaluation accounts for 20%, including case studies on frontier technologies, innovative design of processing techniques, and reports on small-scale R&D projects. Based on the characteristics of the course, distinctive practical projects are designed, such as organizing students to carry out hands-on tasks such as "optimization of microwave-assisted processing technology for agricultural products" and "design of 3D-printed personalized complementary food formulations and processes", encouraging students to leverage their professional expertise and innovative thinking^[18]. A "multi-stakeholder evaluation + timely feedback" mechanism is established, integrating teacher evaluation, enterprise mentor evaluation, student self-evaluation, and peer evaluation to ensure comprehensive and objective assessment. For students with lower performance, personalized improvement plans and follow-up guidance are provided. Students are encouraged to conduct periodic self-assessments to develop a clear understanding of their abilities and pathways for improvement.

Conclusions

Frontier food processing technologies is an emerging interdisciplinary field based on food science, integrating achievements from multiple disciplines such as mechanical engineering, biotechnology, intelligent control, materials science, and digitization. Against the backdrop of "New Engineering" construction, and guided by the core engineering education concepts of "student-centeredness, outcome orientation, and continuous improvement", exploring course teaching reform is of significant practical importance. An interdisciplinary knowledge learning platform is established for students by building a composite teaching team.

Through iterative upgrading of teaching content and models, teaching is synchronized with industrial technology. The cultivation of practical and innovative abilities is strengthened by improving the three-dimensional teaching system. Through precise positioning of talent cultivation directions, accurate alignment between supply and demand is achieved. The assessment mechanism is innovated to evaluate students' comprehensive literacy comprehensively. Under the New Engineering background, the traditional teaching models of food processing courses are no longer able to meet the demands of industrial transformation and upgrading. Universities must continuously track industry technological trends and changes in talent demand, continuously optimize teaching content, innovate teaching methods, and improve the educational system. Keeping pace with the times, they can cultivate more high-quality technical talents with interdisciplinary thinking, innovation capability, and industrial adaptability, injecting strong momentum into the high-quality development of China's food industry.

References

- [1] WANG LJ, LI LH, WANG Y, *et al.* "Five-step" construction path for emerging engineering in agricultural engineering disciplines at local colleges and universities[J]. *Agricultural Engineering*, 2025, 15(12): 127–131. (in Chinese).
- [2] YE M, DENG YX, ZHANG Y, *et al.* Chinese paradigm in the transformation of engineering education: Explorational research and theoretical formation of "Emerging Engineering Education" [J]. *Journal of Science, Technology and Education Studies*, 2023, 3(3): 18–35. (in Chinese).
- [3] CHEN QR, YUN XY, CHENG PF, *et al.* Exploration of practical teaching mode for cultivating talents under the perspective of industry-teaching integration; Principles of food engineering as an example[J]. *Farm Products Processing*, 2026(4): 137–139, 143. (in Chinese).
- [4] LIU L, HU DX, SUN YH. Achievements, challenges, and future paths of emerging engineering discipline construction in China; Analysis based on second batch of emerging engineering education research and practice projects[J]. *Research On Education Tsinghua University*, 2025, 46(3): 119–128. (in Chinese).
- [5] LIU JQ. Research on strategic transformation pathways of food industry enterprises under the background of digital transformation [J]. *Modern Marketing*, 2026(4): 16–18. (in Chinese).
- [6] KONG LF, LI C. Research on the construction of a high-vocational-undergraduate articulation curriculum system for food intelligent processing technology based on the OBE concept [J]. *The modern occupation education*, 2026(1): 133–136. (in Chinese).
- [7] TAN MT, CHEN ZQ, CAO WH. Teaching reform of Food Experiment Design and Statistical Analysis Course based on OBE-BOPPPS dual integration style in the context of new engineering[J]. *Farm Products Processing*, 2025(24): 123–127. (in Chinese).
- [8] ZHANG ZQ. Teaching reform and exploration of the course "Food Packaging" under the OBE concept[J]. *The Food Industry*, 2025, 46(12): 217–220. (in Chinese).
- [9] CUI YW, ZHANG Y, JIANG T, *et al.* Exploration of practical teaching reform in food analysis guided by New Engineering and OBE [J]. *Chinese and Foreign Food Industry*, 2025(23): 134–136. (in Chinese).
- [10] GAO H, WANG Y, GENG Y, *et al.* Teaching reform and exploration of the postgraduate course topics on food safety detection under the background of new engineering[J/OL]. *Farm Products Processing*, 1–4 [2026–01–16]. (in Chinese).

(Continued on page 63)

were equally important and had the greatest influence, followed by C (egg white amount), and finally B (mango concentrate amount).

Among all experimental combinations, formulation A₂B₂C₂D₂, *i. e.* , milk 105 g, mango concentrate 15 g, egg white 30 g, and sugar 15 g, achieved the highest value, confirming the effectiveness of this combination. The result revealed the optimal ingredient ratio and provided clear guidance for the production of mango double skin milk.

The identification of this optimal formulation not only achieved a balance between the flavors of milk and mango, but also ensured a delicate texture and appropriate sweetness of the double skin milk. Through orthogonal experiments, we were able to precisely identify the key factors affecting the quality of the double skin milk and find the best formulation to enhance its sensory quality. These results provide an important reference for the commercial production and quality control of mango double skin milk.

Verification test

The verification test was conducted to confirm the feasibility and repeatability of the optimal formulation obtained from the orthogonal experiments. Following the optimal formulation, *i. e.* , milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g, the double skin milk was repeatedly prepared in three independent trials. The sensory scores were 94, 92 and 93, respectively, with an average of 93, confirming the reliability of the formulation. The verification results demonstrated that this formulation could stably produce high-quality mango double skin milk with good feasibility and repeatability. It provides a solid experimental basis for the commercial production of mango double skin milk.

Conclusions and Discussion

In this study, the formulation of mango double skin milk was

systematically optimized through single-factor experiments and orthogonal experiments. The final formulation was determined as milk 105 ml, mango concentrate 15 g, egg white 30 g, and sugar 15 g. The orthogonal experiments further verified the superiority of this formulation combination, in which the ratio of milk to mango was particularly important, as it determined the richness and the balance of fruit aroma in the double skin milk. Through the verification test, the feasibility and repeatability of this optimal formulation were confirmed, with an average sensory score of 93 points, indicating the high application value of the optimal formulation in actual production.

The mango double skin milk prepared with this formulation had a delicate and smooth texture with no off-flavors. It emits a rich aroma of milk and mango, and is well received by consumers for its unique flavor.

References

[1] LIANG S. Innovation of desserts in the context of health consciousness [J]. China Food Industry, 2024, (13): 173–175. (in Chinese).

[2] LUO ZH, GUO LP. The unforgettable Shunde double skin milk[J]. Little Macaque Intellectual Pictorial, 2021, (101): 46. (in Chinese).

[3] WANG MR. Double skin milk becomes the "new favorite" of milk tea [J]. Food Industry, 2022, (7): 52–54. (in Chinese).

[4] WEI W, ZHANG FJ. Research and development of *Hericium erinaceus* and carrot double skin milk [J]. Farm Products Processing, 2023, (5): 13–17, 22. (in Chinese).

[5] LI SB, JIANG Y. Study on red bean double skin milk[J]. China Dairy, 2013, (3): 60–61. (in Chinese).

[6] HOU HL, ZHANG YY, ZHANG D, *et al.* Optimization of processing technology for carrot-flavored double skin milk[J]. China Dairy, 2020, (10): 63–66. (in Chinese).

[7] YU C, ZENG CZ, LI Y, *et al.* Analysis of the food safety enterprise standard of double skin milk filing in Guangdong province[J]. Journal of Food Safety and Quality, 2021, 12(8): 3423–3228. (in Chinese).

[8] ZHANG T, GONG GH. Research and development of double skin milk [J]. Statistics and Management, 2016(6): 170–171. (in Chinese).

Editor: Yingzhi GUANG

Proofreader: Xinxiu ZHU

(Continued from page 58)

[11] LI J, HUANG S, YE JQ, *et al.* Exploration of project-oriented teaching reform in food analysis courses under the OBE concept [J]. The Food Industry, 2025, 46(11): 139–141. (in Chinese).

[12] XU LL, YE YC. Analysis of countermeasures for the application of artificial intelligence technology in food processing[J]. Modern Food, 2025 (20): 67–69. (in Chinese).

[13] GAO YF, ZHAO XL, WANG YG, *et al.* Focusing on academic frontiers and promoting innovation in biotechnology and food processing: An overview of the 2025 National Conference on Biotechnology and Food Processing Innovation and Industrial Development[J]. China Biotechnology, 2025, 45(9): 143–146. (in Chinese).

[14] JIAO TT, SHI WF, WANG J, *et al.* Exploration of teaching methods for the "Snack Food Processing Technology" course[J]. Modern Flour

Milling Industry, 2025, 39(2): 54–57. (in Chinese).

[15] ZHANG Y, WANG AX. Teaching reform of food processing technology courses under the background of "AI+curriculum ideological and political education"[J]. Mod Agric Sci Technol, 2025(22): 208–212. (in Chinese).

[16] DENG N, WANG JH, LI H. Exploration and practice of the "five-in-one" teaching reform of "Food Nutrition" in universities from the perspective of new engineering[J]. The Food Industry, 2025, 46(10): 156–162. (in Chinese).

[17] REN XF, LIANG QF, WANG B, *et al.* Teaching practice on frontier of food physical processing technology [J]. Agricultural Engineering, 2019, 9(9): 113–115. (in Chinese).

[18] DONG J, YAO MA. Exploration and practice of curriculum ideological and political education in the "Food Processing Technology" course[J]. Modern Flour Milling Industry, 2024, 38(6): 44–46. (in Chinese).