

Degree Program Documentation

Master's Program Brewing and Beverage Technology

Part A

TUM School of Life Sciences
Technical University of Munich

General information:

- Administrative responsibility: TUM School of Life Sciences
- Name of degree program: Brewing and Beverage Technology
- Degree: Master of Science (M.Sc.)
- Standard duration of study and credits:
4 Semesters and 120 credit points (CP)
- Form of study: full time
- Admission: Aptitude assessment (EV)
- Start date: Winter semester (WiSe) 2022/2023
- Language: German
- Main location: Weihenstephan (Freising)
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1 Degree Program Objectives

1.1 Purpose

In the 19th and 20th centuries, brewing and beverage technology developed from a craft trade into a modern industry that operates worldwide. Today's beer and beverage industry utilizes modern production processes and large-scale technical systems that require an interdisciplinary combination of different specialist areas. Extensive engineering knowledge is required, particularly in the planning, design and automation of modern production facilities and the development of new technologies. The markets not only demand high-quality and safe products, but also regular innovations. Increased demands on the conservation of resources, constantly growing competition from the diversity in the beverage and beer sector and the associated market changes are additional constant challenges. German companies continue to be world market leaders in product-related research and development, the establishment of new technologies, raw material production (raw materials, malt, hops) and fermentation technology, and in particular in plant construction in this industry sector. These diverse demands on products and production processes require highly trained specialists with comprehensive expertise in traditional and innovative production systems and plant technologies as well as a profound overview of the entire value chain in beverage production, from raw materials to bottling.

The aim of the Brewing and Beverage Technology degree program is to train interdisciplinary engineers for the brewing and beverage industry as well as the corresponding process technology research and development. The task of graduates is the safe operation of beverage production plants as well as the development of new beverages and corresponding processing methods. They can advance the scientific understanding of corresponding products and processes as well as translate the knowledge gained into innovations. Responsible use of resources in terms of sustainable management is also part of the profile.

Due to their understanding of production and processes, graduates with a Master's degree in Brewing and Beverage Technology also find many other employment opportunities in other industrial sectors such as the food-producing, biotechnological or chemical industries.

1.2 Strategic Significance

For years, the School of Life Sciences (SoLS) has been training process engineers who can design and conceptualize production processes in the brewing and beverage industry. However, TUM is the only university in Germany where all brewing and beverage technology degree programs are supervised by an independent Chair of Brewing and Beverage Technology.

The use of fermentative/biotechnological processes is a connecting element to other related Master's programs of the SoLS (Food Technology, Pharmaceutical Bioprocess Technology). However, the subject-specific focus of those related Master's degree programs is on the food and pharmaceutical industry.

The Master's degree program in Brewing and Beverage Technology is the consecutive follow-up program to the Bachelor's degree program in Brewing and Beverage Technology at the Technical University of Munich (TUM), which is also based at the SoLS. The Master's program builds on this

and focuses on acquiring in-depth process engineering and methodological skills. Students also have the opportunity to specialize in a specific area of brewing and beverage technology and to learn and deepen their independent scientific work in research-oriented topics.

The Brewing and Beverage Technology degree program uses the School's structures and expertise in engineering and biotechnology and complements them with a focus on brewing and beverage technology. Process engineering is a central area of expertise at the SoLS and is represented in the Department of Life Science Engineering. The thematic interlinking of the individual related degree programs mentioned above also enables students to gain an insight into different sectors of the biotechnology industry and thus acquire interdisciplinary skills.

The integration of the study program bundle into the wider environment of the SoLS offers an additional special advantage for the training of brewing/beverage technologists. The Weihenstephan campus has interdisciplinary knowledge of life sciences, especially microbiology, biochemistry and molecular biotechnology. Due to this bundling of competences that are necessary for brewing and beverage technology, graduates can be trained here with up-to-date qualifications. Synergies also result from the existing knowledge in the food sector as well as the good cooperation with the School of Engineering and Design and the Nutritional Sciences/Life Sciences degree program for individual courses.

2 Qualification Profile

Students on the Master's degree program in Brewing and Beverage Technology receive an in-depth education in the field of methodological engineering (together with the related Master's degree programs at the SoLS) and also - specially adapted to the educational profile - an in-depth education in the field of brewing and beverage technology/process engineering. After completing the Master's degree program, students are able to combine the specialist knowledge they have acquired from all areas and apply it in a problem-solving manner. The competences that graduates can demonstrate after successfully completing the Master's degree are listed below.

The content of the following qualification profile corresponds to the requirements of the Qualifications Framework for German Higher Education Qualifications (Hochschulqualifikationsrahmen - HQR) and the requirements contained therein (i) knowledge and understanding, (ii) use, application and generation of knowledge, (iii) communication and cooperation and (iv) scientific self-conception/professionalism. The formal aspects according to the HQF (admission requirements, duration, degree options) are detailed in chapters 3 and 6 as well as in the corresponding subject examination and study regulations.

Knowledge and Understanding

- Graduates have in-depth knowledge of the physical-chemical, technological and microbiological relationships in beer and beverages.
- Graduates know and understand basic process engineering operations that are used to process beverages.
- Graduates know and understand modern concepts from the field of industrial digitalization, such as plant automation and process control.

Use, Application and Generation of Knowledge

- Graduates can analyze and design individual basic process engineering operations in order to generate and/or maintain desired properties in beer and other beverages.
- Graduates are able to design entire beverage production process chains through a combined selection of suitable basic process engineering operations.
- Graduates are able to apply modern concepts from the field of digitalization to specific production processes.
- Graduates are able to analyze and develop beers and other beverages.
- Graduates can utilize the potential of scientific innovations to further develop or redesign beverage production processes through knowledge transfer.

Communication and Cooperation

- Graduates are familiar with the typical working methods of the specialized field and the relevant technical vocabulary.

- Graduates are proficient in interdisciplinary communication and are able to work constructively and solution-orientated in a team.
- Graduates are able to prepare, present and communicate research results in a way that is appropriate for the target group.

Scientific Self-Conception and Professionalism

- Graduates are equally qualified for a job in industrial beer and beverage production as well as for a scientific position at a university/research institution.
- Graduates are able to formulate research questions, design and work on research projects and analyze research results, taking into account scientific findings.
- Graduates are able to select and apply suitable statistical and model-based methods for analyzing and critically evaluating complex data and processes.
- Graduates are able to critically reflect on their actions in their professional environment, especially in relation to society's increasing expectations with regard to sustainable beverage production.

3 Target Groups

3.1 Target Audience

The Master's degree program in Brewing and Beverage Technology is aimed at graduates of a **Bachelor's degree program** in engineering or natural sciences (120 CP) of at least **six semesters** at a domestic or foreign university or a **degree of at least equivalent value** in the fields of bioprocess technology, food technology, brewing and beverage technology or a comparable degree program.

The Master's degree program in Brewing and Beverage Technology is an advanced and in-depth engineering degree program specifically for graduates of relevant engineering and technical Bachelor's degree programs. The course builds in particular on the TUM Bachelor's degree courses in Brewing and Beverage Technology, Food Technology and Pharmaceutical Bioprocess Technology and offers these Bachelor's students an interesting opportunity for further specialization, but also for interdisciplinary specialization. Applicants from other disciplines and career changers are prepared for a successful course of study for the TUM Master's in Brewing and Beverage Technology through an aptitude test and individual counselling.

Applicants should deepen their knowledge in the field of brewing and beverage technology with a view to a future field of activity in the brewing and beverage industry, but also want to continue their interdisciplinary education beyond this. A keen interest in production processes and the creative development of innovative products is a prerequisite.

Future brewing and beverage technologists should be willing to work in an interdisciplinary team in order to be able to work innovatively in a constantly changing industry and contribute responsibly to solving problems affecting society as a whole.

The degree program is currently offered mainly in German in the compulsory subject area and is therefore more suitable for applicants with a very good knowledge of German at TUM. However, there are increasing opportunities to participate in international exchange programs, to integrate an internship abroad, an industrial or research internship or to complete electives at a foreign university. Many electives are also offered in English at TUM and the Master's thesis can be written and supervised in English.

The degree program currently has an average of around 14% international students.

3.2 Prerequisites

Applicants must have successfully completed a **Bachelor's degree in Brewing and Beverage Technology** or other **technical engineering specializations**. A solid basic education in mathematics and natural sciences (biology, chemistry, physics, mathematics) is required. Knowledge of basic engineering subjects such as **technical mechanics, fluid mechanics and thermodynamics** is essential for understanding the content taught in the Master's program. In addition, competences in **brewing and beverage technology fundamentals** - both theoretical and practical - must be demonstrated. The curriculum of the Bachelor's degree program in Brewing and Beverage Technology at the SoLS serves as a basis for comparison.

The application process includes an **aptitude test in accordance with Annex 2 FPSO**.

In principle, **120 CP** from a relevant Bachelor's degree program are required, whereby at least **75 CP** are specified as competences from the subject group listed in **Table 1** (in accordance with Annex 2 FPSO).

Table 1: Subject group - prerequisites for the Master's degree program in Brewing and Beverage Technology¹

Subject group	CP
Chemistry (organic, inorganic and biochemistry)	10
Mathematics incl. statistics	10
Microbiology	5
Physics	5
Hygienic design and hygienic processing	5
Fluid mechanics	5
Technical mechanics	8
Thermodynamics	6
Beverage technology	6
Raw materials technology	5
Wort technology	5
Yeast and beer technology	5
Total	75

Missing competences are additionally acquired through admission requirements. In the event of insufficient subject-specific foundations, modules totaling a maximum of 30 CP from the specified areas of competence can be issued as an admission requirement. These must be completed within one year of starting the program.

The TUM Brewing degree program, which leads to the degree of Diplom-Braumeister (Master Brewer) and is at a lower level than the Bachelor's degree, is a special feature of the brewing degree program at Weihenstephan. For many years, it has mainly been trained brewers and maltsters who have used this degree program for personal development in the academic field. Access to this degree program is also possible with a subject-specific higher education entrance qualification. These graduates may also qualify for admission to a Master's degree program in Brewing and Beverage Technology, subject to certain conditions.

Applicants are expected to have the ability to think in an abstract, logical and system-oriented way, as well as a recognizable interest in and background knowledge of issues in the fields of brewing, beverage technology, food technology and other areas (e.g. engineering, natural sciences, etc.).

¹ Source: FPSO

As the lectures are largely held in German, prospective students must have sufficient knowledge of German. Foreign students must submit a language certificate recognized by TUM (B2 (Goethe), DSH-2/3, B2 (DSD II), 4 (TestDaF), telc Deutsch C1 Hochschule) together with all other documents by the application deadline.

3.3 Target Numbers

The SoLS is aiming for an average number of 25 first-year students on the Master's degree program in Brewing and Beverage Technology, primarily to offer students on the Bachelor's degree program an advanced and in-depth study option who wish to expand their professional development opportunities. In addition, the aim is to increase the number of students from other internal TUM Bachelor's degree programs in engineering and technology and from other German and international universities.

The current graduation rate for students on the Master's degree program in Food Technology is almost 100%.

Students are trained in a variety of modern experimental facilities and laboratories and have the opportunity to integrate TUM internally supervised research internships into their studies. The Master's student groups are designed in such a way that students are optimally supervised and have a wide range of the most innovative technologies and analytical capacity at their disposal.

The brands "Weihenstephan" and the Technical University of Munich contribute to the fact that the degree program is always in high demand at trade fairs. There is also a high level of interest in the degree program at study information days.

Table 2 shows the numbers of applicants, admissions and total students between 2017 and 2021.

Table 2: Development of applicant and enrolment figures 2017 - 2021 for the Master's degree program in Brewing and Beverage Technology

	WS 17/18	WS 18/19	WS 19/20	WS 20/21	WS 21/22
Applications (cases)	53	35	34	27	26
<i>thereof international</i>	7	6	9	2	5
Authorisations (cases)	37	29	25	16	22
Enrolments from applications (cases)	27	27	20	14	15
Proportion of enrolments to admissions (cases) in %	73,0	93,1	80,0	87,5	68,2
Students (cases)	97	85	71	64	55
<i>thereof international</i>	14	12	10	8	n.a.

WS = winter semester, enrolment for this degree program only takes place in the winter semester

Across Germany, only around 720 students are enrolled on a degree program in Brewing and Beverage Technology each year (winter semester 2020/21 with 722 Bachelor's and Master's students²).

Of these, almost 20% are enrolled annually in Weihenstephan for brewing and beverage technology (Bachelor's and Master's). In the period from 2017 to 2021, an average of 90 students are enrolled in the Bachelor's program each year. In the same period, the average number of enrolments for the advanced Master's degree program is 20.

Demand from students for an advanced Master's in Brewing and Beverage Technology in German-speaking countries is generally stable to declining.

A more restrictive aptitude procedure introduced in the winter semester 2016/17 probably led to falling applicant numbers and percentage of admissions. The aptitude procedure was revised again for the winter semester 2022/23 with the aim of harmonizing the procedure for all applicants, including TUM external and international applicants, and aiming for a higher enrolment rate for TUM external applicants with prompt applicant feedback.

² Source: Federal Statistical Office

4 Demand Analysis

The beverage industry and the brewing industry in particular represent an important branch of industry in Germany.

The German beverage industry, one of the leading in Europe, employs around 60,000 people in around 500 companies (with more than 20 employees) with an annual turnover of around 21 billion euros in Germany alone³. Around 27,000 people are employed in the production of beer and almost the same number are employed in the production of soft drinks and mineral water in companies with more than 20 employees. Spirits distilleries and wineries represent a further field of employment.

The brewing industry in particular has a large number of different companies. There are currently over 1,500 breweries in Germany, but over 50% of these are small and medium-sized companies⁴. The brewing industry is characterized by the growth of small (micro) breweries. There are over 10,000 breweries across Europe in 2021. In the United States, the number of breweries more than doubled between 2014 and 2020 and currently stands at around 9,000 businesses.

The global beverage market is of great and steadily growing importance with an average annual growth rate of 2-3% and will reach a total sales volume of around US\$ 1.8 trillion in 2026. Alcoholic beverages have the largest market share with around 76%. Among alcoholic beverages, beer is the largest category, followed by spirits, wine and then ciders, hard seltzers and other fermented beverages⁵.

Graduates have other fields of employment in the non-alcoholic beverage industry. For example, there are around 330 fruit juice producers across Germany with around 7,500 employees⁶, which also represents an important industry.

Germany remains Europe's largest market for non-alcoholic beverages such as drinking water, soft drinks, fruit juices, functional drinks, iced tea and ready-to-drink coffee, so there are also opportunities in this area.

In addition, the world's leading companies in plant engineering (especially brewery production plants, packaging and bottling plants, etc.) are based in Germany. The supply industry (e.g. malting plants, beverage base material manufacturers, etc.) also provides numerous fields of employment.

With a good Master's degree, there is the possibility of a doctorate. However, the majority of graduates consciously decide in favor of a direct entry into industry. Due to the good reputation of Weihenstephan graduates of the Master's degree program in Brewing and Beverage Technology, the international network and the variety of career opportunities, graduates have excellent chances on the labor market.

³ Source: 2021 [Federal Statistical Office](#)

⁴ Source: 2021 [Federal Statistical Office](#)

⁵ Source: 2021 [Federal Statistical Office](#)

⁶ Source: 2020 [Association of Fruit Juice Producers](#)

Master's graduates are offered managerial positions in production companies (e.g. breweries, malt houses, hop refiners, raw material/raw material manufacturers, etc.), in plant engineering and construction (e.g. production plants, bottling and packaging plants, etc.), logistics and the flavor industry.

While Bachelor's graduates are mainly employed in production, graduates of the Master's program are employed in the areas of planning, quality control and research and development. Graduates of the German-language Master's degree program in Brewing and Beverage Technology are in particularly high demand abroad.

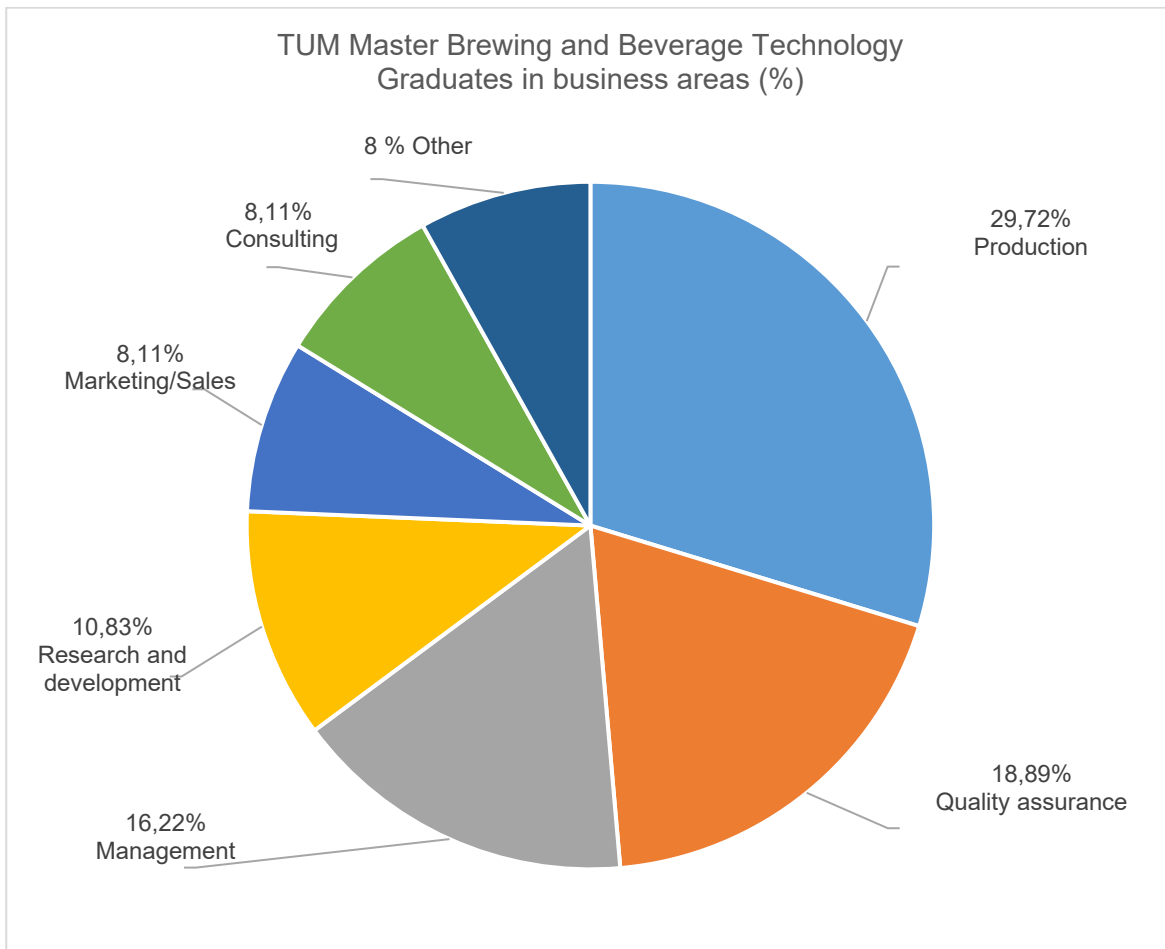
A TUM graduate survey conducted in 2020/21 underpins the positive picture of the career situation for Master's graduates of the Brewing and Beverage Technology degree program.

Graduates have very good career opportunities on the labor market. Regular graduate surveys (since 2018) have shown that almost all graduates have found a suitable job after completing their Master's degree program. 70% of graduates find a job in the first month after graduating.

The majority of graduates (65%) find a career in production companies in the brewing and beverage industry, such as breweries, beverage manufacturers, plant manufacturers, but also in management consultancies and research and development. Graduates also find entry-level opportunities in the food and chemical industries.

Around 30% of graduates find an interesting field of work in production and planning, around 20% in quality assurance, 16% in management/leadership, 10% in research and development and around 24% in areas such as marketing and sales, management consultancy, IT and purchasing (Figure 1).

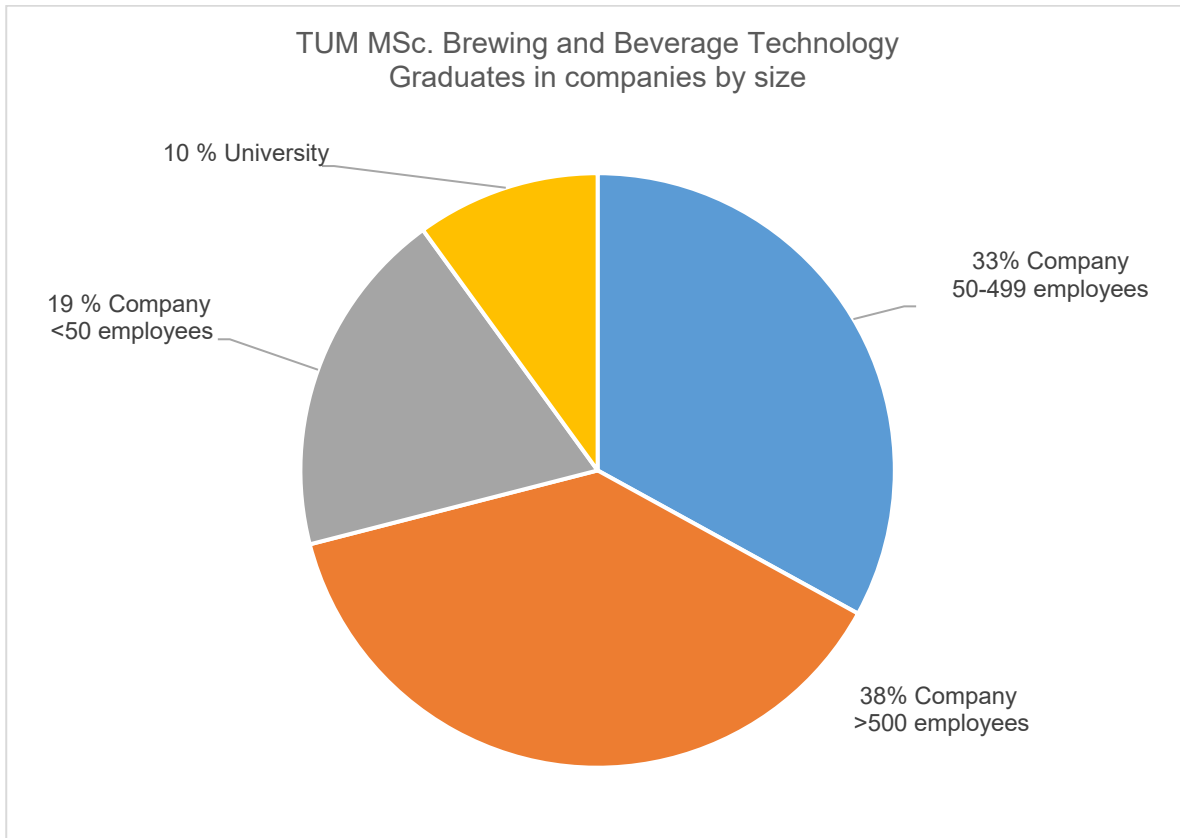
Figure 1: Entry-level occupations of graduates of the Master's degree program in Brewing and Beverage Technology by degree in %



Source: Graduate survey (2018, 2020, n=22)

Surveys in the same period regarding the size of the companies in which TUM graduates found a job showed that around 38% of graduates found work in large companies, 33% in medium-sized companies and 19% in small companies (see Figure 2). In comparison, around 10% of respondents stated that they worked in research and development or teaching at a university.

Figure 2 Entry-level companies by number of employees of graduates of the Master's program in Brewing and Beverage Technology by degree (and universities) in %



Source: Graduate survey (2018, 2020, n=22)

5 Competition Analysis

5.1 External Competition Analysis

Internationally, Brewing and Beverage Technology falls under the Food Science and Technology category. Globally, students are prepared for the speciality through initial courses and undergraduate degrees in Biosciences, Engineering and Physical Sciences or Food and Life Sciences and only later pursue further specialization through graduate courses. Due to the growing importance of the global beverage industry, also in developing countries, and the growth of the craft beer industry, graduate courses are increasingly in demand and offered internationally.

However, the Weihenstephan Master's degree program in Brewing and Beverage Technology has a special position based on a long tradition, industry-proven training methods and focal points, coupled with an industry-oriented research focus, so that the program goes far beyond the standard offerings of other teaching institutions and is one of the international leaders. TUM's Weihenstephan site has been synonymous with study and research in the field of brewing and beverage technology since 1865. What began as a brewing school has since developed into a high-tech, engineering, modern and university-based department. Research and development in fermentation-based beverages, malt-based beverages and alternative protein beverages is one of the main areas of expertise today.

Due to the decades-long training of brewing and beverage technologists at the TUM Weihenstephan Campus, the training and research is very closely linked to the industry and many former graduates can be found today in the management levels of German and international companies.

In Europe, only a few Master's programs with a focus on brewing are offered in the UK (Brewing Science and Practice, the University of Nottingham, Brewing and Distilling, Harriot Watt University). Internationally, programs are mainly offered in the United States. The majority of these programs are merely additional certificates, minors or bachelor courses with a focus on food technology or fermentation science.

In Germany, a Master's program with a focus on brewing and beverage technology is only offered at the Technical University of Berlin, apart from the TUM SoLS in Weihenstephan.

On an international comparison level in the field of Food Science and Technology, TUM ranks first of all German universities compared to TU Berlin in fourth place. Internationally, out of 300 recognized universities worldwide, TUM ranks 37th and TU Berlin in the 201-300 range⁷.

In Germany, two other similar Master's programs in beverage technology are offered at Justus Liebig University in Giessen and at Hochschule Geisenheim University⁸ However, both programs lack a focus on brewing.

⁷ [Shanghai Ranking, 2021 Global Ranking of Academic Subjects](#)

⁸ Source: [Studis-online](#)

The TUM Master's degree program in Brewing and Beverage Technology is the only Master's level program in Brewing and Beverage Technology in Bavaria and the only continuous (Bachelor's and Master's) degree program in Germany.

In addition, studying at TUM offers students access to innovative subjects from the entire TUM catalogue with a technical focus and a network of internationally recognized TUM scientists as potential supervisors for the Master's thesis and further scientific work as part of a doctorate. Students also have many opportunities to gain varied and in-depth experience, for example in an industrial internship, by participating in industry-related research projects, in international exchange programs and in start-ups and venture labs.

5.2 Internal Competition Analysis

There is no comparable Master's program at the TU Munich.

The following Master's degree programs at the SoLS are most closely related: **Food Technology** and **Pharmaceutical Bioprocess Technology**. Parts of the engineering specialization are taken in the Brewing and Beverage Technology degree program together with these two degree programs. Building on the structural and content-related relationship within process engineering and the methodological subjects of automation and control engineering as well as scientific and technical computing, a specialization in the chosen subject area develops over the course of the degree program. The beverage technology and process engineering content taught in the Master's degree program in Brewing and Beverage Technology can only be found in this degree program, thus enabling a clear specialization.

There is a clear distinction to the Master's degree program in **Food Chemistry**, where the focus is on the structure, composition and analysis of food. This program lacks the application-oriented, engineering and process engineering knowledge required to understand production processes and the associated technical requirements. There is also no specialization in the production and development of beer and other beverages and the special requirements associated with this.

6 Program Structure

The four-semester Master's degree program in Brewing and Beverage Technology is designed as a full-time course (120 CP). The degree program builds consecutively on the Bachelor's degree program in Brewing and Beverage Technology offered at the SoLS. While the Bachelor's program is also characterized by a broad scientific education and predominantly lays the foundations for the desired engineering orientation of the course, the Master's program focuses more on deepening specialist and methodological engineering skills. The structure of the degree program is shown in **Figure 3**.

In the first three semesters, compulsory and elective modules totaling 90 CP must be completed. The fourth semester is reserved for the Master's thesis (30 CP). The compulsory and elective modules include lectures as well as tutorials, project work and internships.

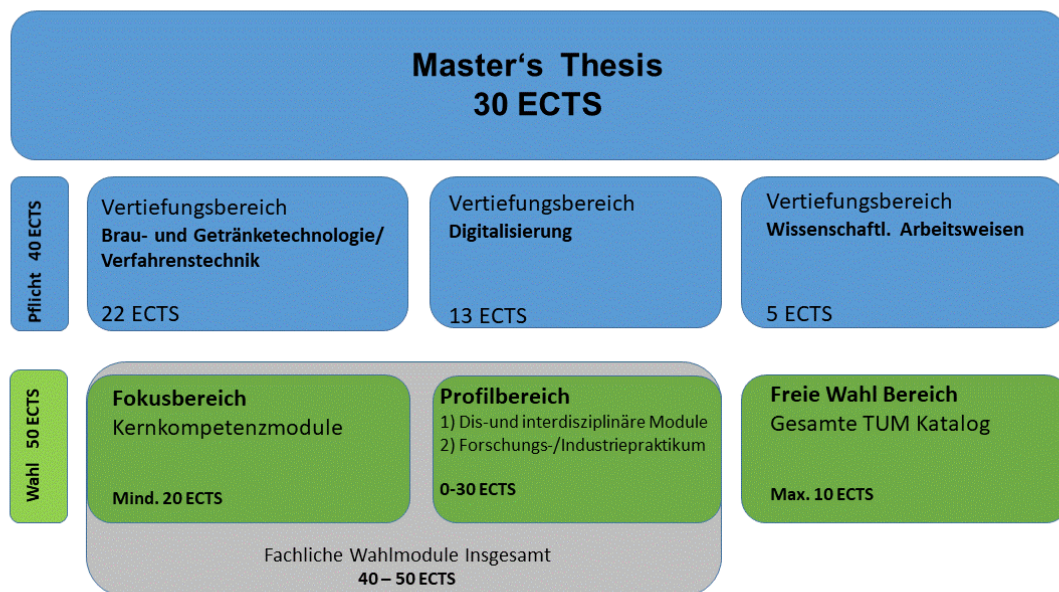
The degree program is offered in German. However, scientific project topics can optionally be worked on and supervised in English. Students can take elective modules in English.

A total of 35 CP must be completed in compulsory modules to acquire the specialist core competences formulated in chapter 2 in the specializations Brewing Process Engineering and Technology and Digitalization. Modules totaling 35 CP are aimed at acquiring skills in the areas of scientific self-image/professionalism as well as communication and cooperation, which primarily cover the Master's thesis but also the **brewing and beverage technology seminar**.

Students hone their own skills profile through elective modules totaling 50 CP. The elective area is divided into three areas: Focus Area, Profile Area and Free Choice Area. The desired engineering profile is ensured by selecting the modules in the focus area. The profile area is thematically broader and also allows students to acquire related competences (e.g. legal and economic competences).

As part of the profile area, students also have the option of acquiring in-depth scientific or practical skills worth a maximum of 10 CP through an individual research internship or an industrial internship of 6 or 10 weeks. Students choose their own areas of interest and are supervised internally at TUM.

Figure 3: Structure of the Master's degree program in Brewing and Beverage Technology



6.1 Specialization area Brewing Process Engineering and Technology (22 CP in total)

The complexity of beverage production requires in-depth academic training in engineering science for students on the Master's program.

In the module **In-depth chapters of brewing and beverage technology** (6 CP), current topics from the field of technology starting from the raw material to the bottled beverage as well as downstream quality processes with reference to science and research are addressed, deepened and supplemented with specialized knowledge. In the process, subject areas are deepened and students are sensitized to currently relevant research focuses and industrial requirements. They gain knowledge of raw material requirements and innovative raw materials, advanced processes and technologies for process optimization and quality requirements.

The process engineering program starts at the same time. The basic operations and concepts of mechanical/dispersive and thermal process engineering are taught in a **process engineering** module (9 CP), which is relevant for the entire degree program. When teaching these basic operations (e.g. filtration, distillation), the focus is on the abstract, formal description. It is shown which laws these processes follow and how these can be summarized in model equations for calculability.

In the **Brewing and Beverage Process Engineering** module (7 CP), all process engineering operations relevant to beer and beverage production **are** dealt with in depth and applied to specific issues. In addition, the brewery systems specialization deals with plant engineering with a focus on the energy supply of heat (boiler system), cooling (compression refrigeration system), compressed air (air compressors) and electrical energy. The basic operations from mechanical and thermal process engineering, which are necessary for understanding, are assumed.

6.2 Specialization area: Digitalization (13 CP in total)

The demand for automation, individualization and digitalization is particularly high in the brewing and beverage industry. In order to meet the requirements of Industry 4.0 (especially digitalization), graduates need extensive methodological knowledge.

This is taught in an application-oriented manner in the **automation and control engineering** module. Not only are the theoretical skills taught, but practical exercises also ensure the application-oriented acquisition of skills.

Students acquire advanced mathematical methodological skills in the **Scientific Computing** module. Students learn algorithms for data analysis and simulation of processes that go beyond the more statistical methods taught in the Bachelor's program.

6.3 Scientific working methods (35 CP in total)

The basis for independent scientific work is laid in the **brewing and beverage technology seminar** (5 CP), which focuses on scientific methodology and literature research. Students should deepen their knowledge of the scientific tools learnt in the course of the Bachelor's thesis. They learn to present and discuss results they have researched themselves and to assess their social implications.

In the final **Master's thesis** (30 CP), students must demonstrate that they can independently and competently develop, practically implement and scientifically analyze a complex topic from the field of food technology. By choosing a topic, students can set their favored focus and thus sharpen their own profile.

In seminars and final theses, students are repeatedly confronted with the responsibility of their own actions. Through reflection with supervisors and fellow students, students learn to categorize their actions in an overall social context, for example with regard to sustainability, which is playing an increasingly important role in the beverage industry.

6.4 Elective options (50 CP in total)

In addition, students can deepen their skills through a wide range of elective modules totaling 50 CP, depending on their inclinations and personal goals. Professional and research internships can also be taken for credit.

Graduates acquire individual, in-depth specialist skills from various flexibly selectable areas of brewing and beverage technology, which reflect a high degree of interdisciplinarity and allow them to develop an individual profile.

The elective area is divided into a **focus area**, a **profile area** and a **free choice area**.

The focus area consists of an elective catalogue closely related to the core competencies of the degree program. Graduates must earn a minimum of 20 CP from the focus area.

The profile area also consists of a predefined catalogue of options. It expands the range of options to include related disciplinary and interdisciplinary areas that serve to sharpen graduates' individual profiles. Research and industrial internships can also be included in the profile area. A total of between 0 and 30 CP can be earned in the profile area, whereby a maximum of 10 CP can be credited for an internship.

In the free choice area, students can choose courses from the entire program (subject-specific or interdisciplinary) from which they expect to acquire useful skills. The selection is only limited by the fact that a maximum of 10 CP can be taken as a free choice.

Students have the optional opportunity to gain their first industrial experience as part of creditable work placements. This gives them an initial insight into their chosen industrial sector, familiarizes them with characteristic working methods and enables them to link these with the content of their studies. As a result, they are later able to act on the labor market and can reflect on their own competence profile in the relevant fields of activity, continuously expand it and place the set work goals in a professional and socially meaningful context.

In optional university internships or seminars, which are often carried out in groups, students acquire the ability to solve problems in a team and acquire communication skills and team spirit. In common, frequently practiced learning groups, students motivate each other to complete examinations quickly and successfully. This enables them to recognize potential conflicts in a group, overcome them using suitable methods and thus develop a suitable solution process that leads to success. Thanks to the self-organized and individually selectable composition of the course, Master's graduates are able to assess their own weaknesses and strengths and learn to set themselves realistic work goals.

In addition to the above-mentioned elements firmly anchored in the degree program, which build and train skills such as commitment and a sense of responsibility, there is also the opportunity to gain extended experience within the framework of student activities (e.g. through activities in the student council, in the Weihenstephaner Industrierunde). Participation in TUM-wide associations and working groups can give students a broad view of interdisciplinary fields of interest.

6.5 Mobility window

A mobility window was created in the 3rd semester of the degree program. This semester is characterized by an almost complete absence of compulsory courses. The majority of elective credits are earned here. These elective credits can also be earned by taking suitable courses at foreign universities. The compulsory module **Brewing and Beverage Technology Seminar** to be completed in the 3rd semester can also be completed by taking an equivalent foreign course. However, if this is not possible, this coursework can also be completed without attendance at TUM, as this module is predominantly characterized by self-study.

6.6 Sample study plans

The general study program schedule over the standard period of study of four semesters is shown in **Figure 4**.

Figure 4: General study plan for the Master's degree program in Brewing and Beverage Technology

Semester	Modules						CP/PL
1.	Automation and control engineering (compulsory) 4 CP	In-depth chapters of brewing and beverage technology (compulsory) 6 CP	Process engineering (compulsory) 9 CP	Elective module 1 5 CP	Elective module 2 5 CP		29/4
2.		Scientific computing (compulsory) 5 CP	Brewing and beverage process engineering (compulsory) 7 CP	Elective module 3 5 CP	Elective module 4 5 CP	Elective module 5 5 CP	31/6
3.	Brewing and beverage technology seminar (compulsory) 5 CP	Elective module 6 5 CP	Elective module 7 5 CP	Elective module 8 5 CP	Elective module 9 5 CP	Elective module 10 5 CP	30/6
4.	Master's Thesis 30 CP						30/1

Mobility window (highlighted in yellow in the original image) covers Semester 3.

Legend
 Dark blue = compulsory module Master's thesis
 Grey = compulsory modules
 Light blue = elective modules
 CP = Credits, PL = Examination

The sample study plan (**Figure 5**) is one of the many options for students to put together their study plan.

Figure 5: Exemplary curriculum of the Master's degree program in Brewing and Beverage Technology

Semester	Modules						CP/PL
1.	LS30006 Automation and Control Engineering (compulsory) 4CP	LS30005 Advanced Chapters of Brewing and Beverage Technology (compulsory) K + LL 6 CP	LS30010 Process Technology (compulsory) K 9 CP	LS30029 Process Analysis and Digitalization (choice - focus) K 5 CP	WZ5163 Technological Quality Assurance in Brewing (Wahl - Fokus) K 5 CP		29/4
2.		LS30007 Scientific Computing (compulsory) K 4 CP	LS30008 Process Engineering in Brewing and Beverage Technology (compulsory) K 7 CP	LS30025 Practical Apparatus Engineering in Life Sciences: A Project in the Makerspace (elective - profile) PA 5 CP	WZ5134 Process Simulation (Election Focus) K 5 CP	WZ5413 Legal Aspects of Manufacturing and Distribution Requirements in the Beverage Industry (Choice - Focus) K 5 CP	31/6
3.	LS3009 Brewing and Beverage Technology Seminar (compulsory) WA + PRÄ 5 CP	LS30020 Research Internship (Option - Profile) B 10 CP	LS30028 Marketing in the Consumer Goods Industry (Election profile) K 5 CP	WZ5005 Materials Engineering (choice - focus) K 5 CP	WZ5121 Industrial Engineering (Choice - Focus) K 5 CP		30/6
4.	WZ5907 Master's Thesis W 30 CP						30/1

Legend

Dark blue = compulsory module Master's thesis
 Grey = compulsory modules
 Light blue = elective modules focus area Green = Profile area optional modules (RGB Orange = optional module free choice area (RGB

SE = Seminar; CP = Credit Points; PL = Examination;
 SL = Academic achievement; K = Written exam; LL = Laboratory work; PA = Project work; PRÄ = Presentation;
 W = Scientific paper

Due to the 50 CP available for electives, including a creditable internship, there are very diverse and flexible opportunities for students to specialize and take subjects from the focus, profile and the entire TUM catalogue.

The catalogues are constantly updated and expanded. Current information is available online on the [program website](#) and in the module handbook. Further support with specific curriculum planning, the integration of industrial and research internships or a stay abroad is offered by the student advisory service.

7 Organization and Coordination

The Master's program Brewing and Beverage Technology is offered by the TUM School of Life Sciences, the Department of Life Science Engineering at the Weihenstephan campus. Professors from all areas of the Department of Life Science Engineering are involved in teaching and supervising scientific work. In addition, the **School of Engineering and Design**, Garching Campus and the **School of Management**, Munich Campus offer and support modules in elective areas.

Student counselling is provided by the Campus Office in cooperation with the Chair of Brewing and Beverage Technology.

Administrative aspects of study organization are partly the responsibility of the central departments of the TUM Center for Study and Teaching (TUM CST) and partly of the TUM School of Life Sciences (see overview below):

- Student Advising: Student Advising and Information Services (TUM CST)
studium@tum.de
+49 (0)89 289 22245
Offers information and counselling for:
Prospective and current students
(via Hotline/Service Desk)
- Departmental Student Advising: Team Student Advising
brewing-foodtec.co@ls.tum.de
+49 (0)8161 71 6515
- Academic Programs Office (within department/school), Infopoint, etc:
Campus Office Weihenstephan
campus.office@ls.tum.de
- Study Abroad Advising/
Internationalization: TUM-wide: TUM Global & Alumni Office
internationalcenter@tum.de
Departmental: Campus Office Weihenstephan
international.co@ls.tum.de
- Gender Equality Officer: Prof Aphrodite Kapurniotu
akapurniotu@mytum.de
- Advising – Barrier-Free Education: TUM-wide: Service Office for Disabled and Chronically Ill Students (TUM CST), handicap@zv.tum.de
+49 (0)89 289 22737
- Admissions and Enrollment: Application and enrolment (TUM CST)
studium@tum.de

+49 (0)89 289 22245

Admission, Enrollment, Student Card,
Leave of Absence, re-Registration, de-Registration

- Aptitude Assessment (EV): TUM-wide: Admissions and Enrollment (TUM CST)
Departmental: Student Advisory Service Team
Dr Sabine Köhler
application.co@ls.tum.de
+49 (0)8161 71 3336
- Semester Fees and Scholarships: TUM-wide: Fees and Scholarships (TUM CST)
beitragsmanagement@zv.tum.de
- Examination Office: TUM-wide: Central Examination Office (TUM CST)
Departmental: Team Examination
Campus Office Weihenstephan
examination.co@ls.tum.de
- Examination Board: Prof. Dr.-Ing. Thomas Becker (Chairman)
Eva Guyot (Secretary)
- Quality Management –
Academic and Student Affairs: TUM-wide: Studies and Teaching -
Quality Management (TUM CST)
www.lehren.tum.de/startseite/team-hrs/
Departmental: Team Quality Management
qm.co@ls.tum.de
Campus Office Weihenstephan
- Internship: Counselling in all questions concerning practical
training and internship semester
<https://www.praktikantenamt-weihenstephan.de/>
+49 (0)8161 / 71 3710

8 Enhancement Measures

A structural standardization was achieved with regard to process engineering training. All degree programs included in the study program bundle (Food Technology, Brewing and Beverage Technology, Pharmaceutical Bioprocess Technology) include an overarching basic education oriented towards basic process engineering operations, which is complemented by a clear subject-specific education (here: module "Brewing and Beverage Process Engineering"). In terms of content, this was already the case before, but was reflected differently in the various degree programs with regard to the titles of the modules.

In the methodological competences, structural homogeneity was achieved via the degree programs related to the Brewing and Beverage Technology degree program in the degree program bundle. As a result, all degree programs in the degree program bundle now share the modules in the specialization area of digitalization (see section 6.2).

The transfer of certain essential content to the Master's program had become necessary due to previous changes that had already been implemented in the Bachelor's program. This had already been taken into consideration when planning the previous Bachelor's conversion. Specifically, the two central modules "Process Engineering" and "Process Automation and Control Engineering" were transferred to the Master's program with adapted depth. Regardless of the necessity of the shift in terms of the timetable, positioning the two subject areas in the Master's program is also expedient in terms of their complexity.

In order to create greater freedom of choice for students to develop their own profile despite these additional modules, the other compulsory content has been strongly prioritized towards the core competencies. For example, the modules "Rheology" and "Simulation of Production Systems" are no longer compulsory. These modules, which continue to offer a particularly suitable skill set for the degree program, have instead been incorporated into the focus elective area (see section 6.4. for a distinction between the various elective areas). The obligation to complete industrial placements has also been uniformly waived in all degree programs of the degree program bundle. However, industrial placements can still be included as elective modules according to the students' inclinations. Other subject-specific content that was previously taught in a separate "Beverage Bottling Systems" module has been partially integrated into the "Brewing and Beverage Process Engineering" module in order to maintain the teaching of the respective core competences in these areas. The compulsory module "Physical Chemistry" was discontinued as, following analysis, it was determined that the knowledge required for the overall acquisition of skills for the degree program had already been acquired in the Thermodynamics module in the Bachelor's degree program.

All of these interventions have led to students being given significantly greater options for organizing their own individual studies. Particularly noteworthy is the fact that the prioritization has made it possible to create a mobility window in the third semester.