UNIVERSITY OF COPENHAGEN
FACULTY OF SCIENCE

Tropical Fruit Production
LPLK10367U

Notes taken during the course, including lectures, exercises, curriculum, and practicals

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Link to Git repo.: https://github.com/DanishUnicorn/dnf_dpa

Course Description

Education

MSc Programme in Agriculture
MSc Programme in Environment and Development
MSc Programme on Global Environment and Development

Content

The course focuses on developing capacities for sustainable production of tropical crops. The students will be exposed to major crop science elements that are instrumental for a sustainable crop production. Focus is on optimizing the use of agrobiodiversity and management practices considering the socio-economic characteristics and climate change challenges.

Main disciplines are:

i. Agronomy with reference to tropical conditions.
Tropical crop physiology; crop genetic resources, agrobiodiversity and breeding; crop management; crop protection; soil fertility. Cultivation of crops under challenging conditions of climate change (e.g drought, salinity).

ii. Tropical Crops
An overview of major tropical crops groups in relation to their uses (roots and tubers; legumes; minor cereals; spices; stimulants; underutilized species), their intrinsic properties and their cultivation with special emphasis on small-holder conditions and resilience for climate change.

iii. Cropping systems
Crop production optimization strategies for sustainable production (intercropping, use of legumes for mitigation/adaptation). Innovations to optimize sustainable production systems (crop: phenotyping, breeding, protection). The use of agrobiodiversity for diversification, sustainable intensification and value chain enhancement.

Learning Outcome

Provide students, having a BSc-level background in agricultural, social sciences or sciences involved with development of the tropical region, with a comprehensive understanding of the properties of selected tropical environments, crop species and their management facing climate change. Focus is on climate related production constraints; that is abiotic and biotic stresses, and human endeavor to optimize crop production in small-scale farming, within the context of poverty alleviation and sustainable crop production.

When students have completed the course, they should have attained:

Knowledge

- Manage key elements to characterize production systems in the tropics
- Demonstrate knowledge of the principles of tropical crop production
- Understand the characteristics of major tropical crops
- Demonstrate overview of tropical cropping systems in relation to agro-ecological and socio-economic conditions
- Demonstrate knowledge on different strategies to optimize production systems in the tropics
- Manage basic tools for participatory work and research

Skills

- Characterize production systems of tropical areas of the globe
- Design cropping calendars for selected major crops species
- Analyze and synthesize diverse types of information and data on tropical crop production
- Apply a relevant analytical software for statistics
- Apply relevant participatory rural appraisal methods
- Develop tropical crop production plans in relation to given agro-ecological and socioeconomic conditions
- Design and analyze the implementation of projects in a tropical crop production environment

Competences

- Data management, analysis, and critical approach
- Assess and formulate agronomic components of development support programmes
- Advice extension and research institutions in tropical countries
- Perform and interpret quantitative and qualitative statistical information to analyze scenarios of crop production and innovation
- Propose innovative optimization strategies for sustainable crop production in the tropics

Litterature

Papers and videos uploaded on Absalon
Tropical Crop Production I - Selected papers
Tropical Crop Production II – Manual for practical and theoretical exercises

Recommended Academic Qualifications

Basic courses in biology, statistics, social sciences and sciences related to sustainable development
Academic qualifications equivalent to a BSc degree is recommended.
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Teaching and Learning Methods

The course applies blended learning with lectures supported by videos, digital tools, theoretical and practical exercises.

Workload

Table 1: *A table with an overview over the workload for the course.*

Category	Hours
Lectures	30
Preparation	68
Theory exercises	55
Practical exercises	24
Excursions	7
Project work	8
Guidance	10
Exam	4
Total	206

Exam

Table 2: *A table with an overview over the workload for the course.*

Credit	7.5 ECTS
Type of assessment	Oral examination, 30 min
Type of assessment details	During the course the student participate in group work in which they write a group report (approximate 10 pages). The students are individually examined in the content of the group report and are further examined in the rest of course curriculum. Examination in the report weight 35 % and examination in curriculum weight 65 %. No preparation time before the oral examination.
Examination prerequisites	Submitted and approval of the reports for theoretical and practical exercises
Aid	All aids allowed
Marking scale	7-point grading scale
Censorship form	• No external censorship • Several internal examiners
Re-exam	• As the ordinary exam. • If the student did not participate in a approved group report, an assignment is given three weeks before the exam. The student has to hand in an individual report based on the assignment (approximate 5 pages). At the oral examination the students will then be examined in the report and in the rest of the curriculum. Examination in the rapport weight 35 % and examination in curriculum weight 65 %.

Contents

Chapter 1
Lecture Notes

1 Lecture 01 - 04/08-2025

Topics of the course lectures

The course will be covering the following topics:

- Week 1
  Reading materials for self-study and start the project work
- Week 2
  Monday 4 August: Introduction to the course and Basic constituents of milk and alternatives (Lilia, Jorg) + project work
  Tuesday 5 August: Dairy processing (Jorg) and Introduction and Sustainable Nutrition (Merete & Lea)
  Wednesday 6 August: Digestion and Nutritional effects of dairy protein (Lilia, Jorg, Mads) + project work
  Thursday 7 August: Lactose, calcium and lipids (Lilia, Jorg, Andreas) + project work / Pitch your idea
  Friday 8 August: The challenge: sustainable and healthy diets - from purpose to practice (Thom, Nick Smith) + project work
- Week 3
  Monday 11 August: Process-induced changes (Qing Ren)
  Tuesday 12 August: Process-induced changes (Qing Ren, Lilia)
  Wednesday 13 August: Dairy/Plant-Hybrid Products (Iben, Lilia)
  Thursday 14 August: Human Nutrition (Inge, Marta, Jordi)
  Friday 15 August: Gut Microbiota (Torben)
- Week 4 & 5
  Project work

Structure of the group project

The structure of the report was defined and must adhere to the following:

- 30 +/- 10 pages
- Product description, including the purpose of “why” the product
- Intended nutrition or health benefits
- Description of the ingredients

- Description of the claimed beneficial effect
- Target consumer group
- Dietary pattern of the chosen consumer group, and how the product would fit in that
- Formulation - which raw materials will be used, and why. In case of ingredients, which processes would they already have undergone prior to product formulation?
- Processing - how will the product be processed? Process flow diagram and identify the impact of processing steps on nutritional value (could it impact the nutrition/health benefits)
- Nutritional Quality - To quantitatively or qualitatively estimate the nutritional and sustainability aspects of the novel product

2 Lecture 02 - 04/08-2025

The physical properties of milk are defined by:

Table 1.1: *Examples of physical properties of milk*

Property	Value	Unit
Osmotic Pressure	$= 700$	$[kPa]$
Freezing-Point Depression	≈ 0.54	$[K]$
Electrical Conductivity	≈ 0.5	$[A/(V \cdot m)]$
pH Value	6.7	
Ioinic Strength	≈ 0.08	$[molar]$
Water Activity	≈ 0.993	

3 Lecture 03 - 05/08-2025

Chapter 2
Literature résumés

This section of the course notes is designed to streamline access to the key findings from each reading material (RM), providing a concise and accessible overview of essential information. Created through experimentation with various AI platforms, this chapter also serves to enhance prompt engineering skills, exploring diverse methods of note-taking for maximum efficiency and clarity. The procedures for creating these summaries have varied, but all methods share a common approach: each RM has been fully read, with summaries and notes prepared after completing each respective subsection. By using these AI-co-op'ed approaches, these notes aim to be both a reliable reference and a resource for continuous improvement in capturing complex microbiology concepts.

1 1st Reading Material from the Curriculum

1.1 Milk for Liquid Consumption

Liquid milk is treated by pasteurization or sterilization to ensure safety, extend shelf life, and retain flavour. Raw milk is considered unsafe and is restricted in many countries. Pasteurized milk retains better flavour, while sterilized milk offers longer shelf life, especially valued in cooking. Fat content is usually standardized, but low-fat and skim milks are also common. Some products are fortified or processed via ultrafiltration for consistent protein content, although this may be legally restricted. Quality attributes vary by use, and packaging is essential for hygiene [1].

Manufacture

Thermalization reduces lipase activity and psychrotrophic growth, aiding shelf life. Homogenization prevents creaming but increases lipolysis risk, requiring higher heat (e.g., 20 s at 75 °C). Low pasteurization (15 s at 72 °C) kills pathogens while preserving natural inhibitors, though heat-sensitive compounds like agglutinins and immunoglobulins are degraded in high-pasteurized milk. Packaging hygiene is crucial to prevent recontamination and preserve shelf life [1].

Shel Life

Shelf life is influenced by bacterial growth, enzymatic activity, and chemical/physical changes. Key factors include storage temperature, recontamination, and Bacillus cereus spore levels. Below 7 °C, psychrotrophs dominate spoilage. Hygiene in packaging is essential; rapid tests help detect recontamination [1].

Extended-Shelf-Life Milk

ESL milk combines long shelf life with near-fresh flavour. One method applies short-time direct UHT treatment (e.g., 2 s at 140 °C) with aseptic packaging; enzymes like plasmin may still affect taste after weeks. The second method involves microbial removal via microfiltration or bactofugation, often followed by partial UHT sterilization of retentate and cream. Aseptic packaging is essential. Cooked flavour is minimized by limiting heat to fat-rich fractions [1].

1.2 Sterilized Milk

1.2.1 Description

Sterilized milk must be microbe-free, shelf-stable at ambient temperature, and retain acceptable flavour and nutritional value. UHT sterilization (e.g., 1 s at 145 °C) minimizes browning, off-flavours, and vitamin loss. To prevent spoilage, packaging must be aseptic, and milk free from heat-resistant enzymes. Homogenization avoids creaming and coalescence. Lactulose content is used to identify UHT-treated milk [1].

Manufacture

Sterilized milk is made via in-bottle, mild in-bottle, or flow-through UHT processes. Psychrotroph enzymes (esp. from *Pseudomonas*) are heat-resistant, so raw milk must be fresh. UHT heating (>140 °C) ensures safety but risks casein aggregation, off-flavors, and vitamin loss. Aseptic homogenization and deaeration are crucial to prevent oxidized flavor. Oxygen- and light-tight packaging prolongs shelf life [1].

Shelf Life

Spoilage of in-bottle sterilized milk may result from surviving spores (e.g., *B. subtilis*, *B. stearothermophilus*) or leaky packaging. UHT milk mainly deteriorates via recontamination or residual heat-resistant enzymes, causing gelation, off-flavors, or plasmin-induced bitterness. Nonenzymatic spoilage includes oxidation, Maillard reactions, and light effects. Shelf life is tested via incubation, oxygen pressure, or ATP bioluminescence [1].

1.3 Reconstituted Milk

Reconstituted milk is made by dissolving milk powder in water; recombined milk adds anhydrous milk fat to reconstituted skim milk. It mimics whole milk but lacks natural fat globule membrane components. Filled milk uses vegetable oil instead of milk fat. Toned milk blends buffalo milk with skim milk to reduce fat content [1].

1.4 Flavour

Good flavour means a bland taste without off-flavours. Sources include microbial growth (e.g., *B. cereus*, *P. fragii*), plasmin, lipoprotein lipase, and oxidation by Cu or light. Heat causes cooked, UHT ketone, or sterilized-milk flavour, depending on thermal load. Sunlight flavour arises from methionine oxidation with riboflavin present [1].

1.5 Nutritive Value

This section addresses changes in nutritive value due to deliberate changes in composition, processing, and storage. For details on the nutritive aspects of milk components, see Subsections 2.1.2, 2.2.4, 2.3.3, 2.4.5, and Table 2.18 in the book [1].

Modification of Composition

Milk of modified composition includes low-fat, skim, or vitamin-fortified types. Filled milk uses vegetable oils, often rich in vitamins D and E, with added antioxidants. Calcium may be added as lactate or whey permeate. Lactose-free milk, produced by adding lactase after UHT treatment, has limited success due to cost and sweet taste. Functional foods and specialised products are also being developed [1].

Loss of Nutrients

Pasteurized and UHT-sterilized milk lose few nutrients, while in-bottle sterilized milk shows greater loss, especially of lysine and vitamins due to Maillard reactions. Losses mainly affect vitamin C and B vitamins (B_1, B_2, B_6, B_9, B_12). Oxygen and light accelerate degradation, with riboflavin acting as a catalyst. Packaging permeability is crucial to prevent losses [1].

1.6 Infant Formulas

Breast feeding is preferable, but when not possible, infant formulas based on cows' milk fractions are used. Unmodified cows' milk is unsuitable. Due to higher risk of microbial contamination, strict hygiene is essential during preparation and storage. Liquid formulas should be refrigerated [1].

Human Milk

Human milk differs from cows' milk in composition and varies by individual and lactation stage. It contains more essential fatty acids, cholesterol, and oligosaccharides, but less protein, casein, and minerals. It includes immunoglobulin A, lysozyme, and lactoferrin, and lacks β-lactoglobulin. Infant formulas require significant adjustment to mimic its properties [1].

Formula Composition and Manufacture

Infant formulas use skim milk and sweet whey (e.g., 1:5 ratio), often with added lactose, vegetable oils, vitamins, Fe, and Cu. Whey is partly desalted. Oligosaccharides or lactulose may be added. Manufacture involves wet mixing, pre-emulsification, pasteurization, and homogenization. Products may be UHT-sterilized, canned, or spray-dried [1].

Bibliography

[1] P. Walstra, J.T.M. Wouters, and T.J. Geurts. *Dairy Science and Technology*. 2nd ed. CRC Press, 2005. DOI: 10.1201/9781420028010. URL: https://doi-org.ep.fjernadgang.kb.dk/10.1201/9781420028010.