

Ministry of Higher Education
 Salahaddin University
 College of Agricultural Engineering Sciences
 Plant Protection Department



Weeds and Weed Control
Fourth Grade
Spring Semester (2022-2023)
Instructor: Saber Wasman (PhD)
Lecture 5

1

What is natural product?

- A natural product is a chemical compound or substance produced by a living organism
- They may be extracted from tissues of plants, marine organism or micro-organism fermentation
- Any biological molecule is a natural product
- In general, the term is reserved for secondary metabolites (carotenoids, saponines, phenolic compounds, alkaloids, terpenes etc.), produced by an organism
- They are not essential for normal growth, development or reproduction and its survival



2



History of plant natural products

- The history of the extraction of natural products dates back to Mesopotamian and Egyptian times, where production of perfumes or pharmaceutically - active oils and waxes was a major business.
- In archaeological excavations 250 km south of Baghdad extraction pots from about 3500 BC were found, made from a hard, sandy material presumably air - dried brick earth.
- Several Sumerian texts also confirm that a sophisticated pharmaceutical and chemical technology existed

3



History of plant natural products

- Natural extracts were subjected to separation into component compounds, which were then purified and analyzed.
- In the late 1800's, synthetic methods were being developed for some of these natural compounds.
- It was discovered that natural extracts had more complex compositions and properties than salts and minerals.

4



Natural products are often divided into **two** major classes:

1. Primary metabolites
2. Secondary metabolites



5



Primary metabolites

- Organic molecules that have an intrinsic function that is essential to the survival of the organism that produces them (i.e. the organism would die without these metabolites).
- Examples of primary metabolites include the core building block molecules (**nucleic acids, amino acids, sugars, and fatty acids**) required to make the major macromolecules (DNA, RNA, proteins, carbohydrates, and lipids) responsible for sustaining life.

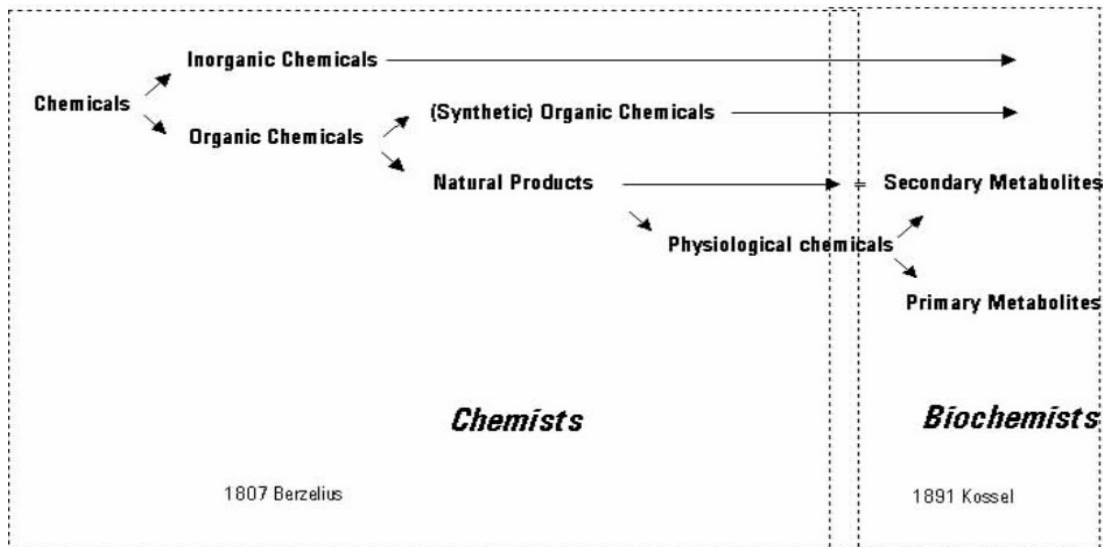
6



Secondary metabolites

- Organic molecules that typically have an extrinsic function that mainly affects other organisms outside of the producer.
- Secondary metabolites are not essential to survival but do increase the competitiveness of the organism within its environment.
- Secondary metabolites, in contrast to primary metabolites are dispensable and not absolutely required for survival.

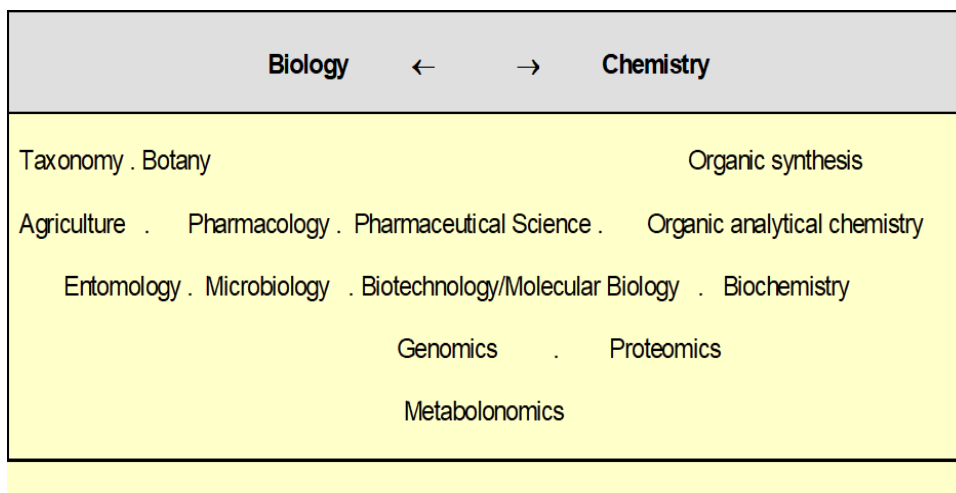
7



8



The study of natural products is multidisciplinary



9

Where do we find natural products?



- Natural products may be extracted from the cells, tissues, and secretions of microorganisms, plants and animals.
- A crude (unfractionated) extract from any one of these sources will contain a range of structurally diverse and often novel chemical compounds.
- Chemical diversity in nature is based on biological diversity, so researchers travel around the world obtaining samples to analyze and evaluate in drug discovery screens or bioassays.
- This effort to search for natural products is known as bioprospecting.

10



Natural products as a bioherbicide

- Many secondary plant natural products are linked with bioherbicidal influences.
- Some secondary plant metabolites, such as phenolics and alkaloids, play an essential role in natural plant activities such as germination and early growth.
- Certain crop species can be used as bioherbicide and their allelochemical extracts can be used to advantage to suppress and reduce negative effects of weeds on crop production

11



Allelopathy

- The phenomenon of plants affecting other neighbouring plants through releasing chemicals was originally mentioned as early as **370 BC** by Theophrastus
- The term **Allelopathy** was first mentioned by **Molisch in 1937**
- It is a Greek hybrid word, “**Allelon**”, which means “of each other” and “**pathos**” meaning “suffer”

12



What is Allelopathy?

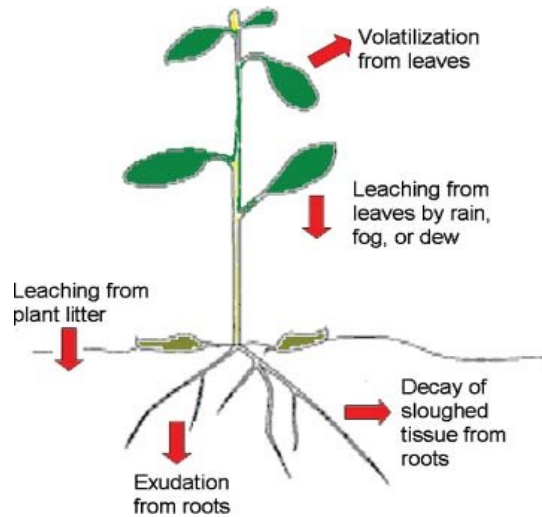
- Any direct or indirect **harmful** or **beneficial** effect of one plant or a microorganism on other plants by releasing chemicals termed allelochemicals to the environment
- According to the International Allelopathy Society (International Allelopathy Society, 1996), allelopathy is
 “any process involving secondary metabolites produced by **plants, algae, bacteria** and **fungi** that influences the growth and development of agricultural and biological systems

13



- Plants which have allelopathic potential must produce allelochemicals, which must be released into the environment and must be available for transport to the target plant to be taken up
- Allelochemicals are released to neighbouring plants by different mechanisms involving
 - Root exudation,
 - Leaching,
 - Volatilization and
 - Decomposition of plant residue

14



15



Field Crop Production

- Certain **crop** species can be used as allelopathic plants and their allelochemical extracts can be used to advantage to suppress and reduce negative effects of weeds
- It could help to avoid environmental pollution soil contamination
- Crop allelopathy could be achieved by using such crops as cover crops, companion crops as well as components of the crop rotation system

16



- Selecting crops to release allelochemicals may minimize the intensity not only of weeds, but also pests, diseases and nematodes
- Crop Allelopathy may play an essential role in the development of biological herbicides
- Some weeds have been shown to have allelopathic properties against some crop plants

17

Weed Management



- Weeds are defined as plants growing in unwanted locations which compete with other plants for resources such as **water, nutrients, and light**, reduce the yield and quality of crops and may contaminate produce with weed seeds
- About 7000 weed species have been identified
- Nearly 200-300 of them are problems for farmers .
- Using **herbicides** to minimize the negative impact of weeds on crop yield has many risks.

18



- Using chemical herbicides to suppress weeds, poses risks to environment, health, water contamination, and soil microorganisms
- There are more than 470 biotypes of weeds that are resistant to chemical herbicides
- Plants that have allelopathic activity can be used as bioherbicides for weed suppression
- Allelopathy may be considered as a possible tool to minimize weeds and enhance crop production

19



Soil and Allelopathy

- Soil is a system which gives a living biological environment for living microorganisms such as fungi, bacteria, algae, protozoa and actinomycetes
- Soil is the environment where allelopathic activities happen
- Soil type significantly affects the allelopathic potential of allelochemicals

20



- Allelopathic activity of several allelochemicals can be reduced by **organic matter, ion exchange capacity, inorganic ions, and mineral reactive surfaces**
- Allelochemicals incorporated into soil may be transformed when movement happens and they are metabolized by soil microbes
- Soil **pH** affects availability of soil nutrients and hence plant growth
- **Phenolic compounds** may reduce soil pH due to soil acidification

21



What are Allelochemicals?

- The allelopathic compounds present in some plants are mostly secondary metabolites, including **phenolics, terpenoids, and alkaloids**
- There are many plants that produce allelochemicals during their growth, **such as** sorghum, wheat, alfalfa, barley, corn, asparagus, coffee, tea, tobacco, and sunflower
- These allelopathic crops can produce allelochemicals during decomposition of their plant residues, such as **roots and leaves**

22



Phenolic acids as allelochemicals

- Phenolic acids are a class of most important common secondary metabolites which are found in plants and act as allelochemicals in natural ecosystems
- Phenolic acids originate from the shikimic acid and acetic acid metabolic pathways in plants
- Phenolic acids consist of a hydroxyl group bonded to an aromatic hydrocarbon group

23



- Phenolic compounds are one of the big groups of plant metabolites which have numerous important functions in some plant species
- The primary structures of phenolic acids are benzoic acids and derivatives of cinnamic acids
- Most of the phenolic acids which have already been identified as allelochemicals are extracted from plant parts, such as shoots and roots

24



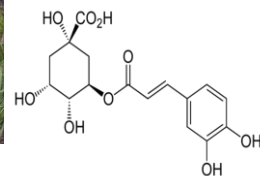
- Many years ago, de Candolle (1830) noticed suppressive effects of root exudates on the neighbouring plants
- It was difficult to determine if phenolic compounds were involved in this effect and if so, which ones.
- After 1980s there was a revolution: numerous methods such as column chromatography on silica, ion exchange chromatography were developed which enabled phenolics to be found and extracted from plants

25

1. Chlorogenic acid

- Chlorogenic acid is produced by a combination of caffeic acid and quinic acid and usually appears in high concentration in comparison with other phenolic acids in many fruits, vegetable, and field crop plants.
- Chlorogenic acid plays an essential role as a dietary antioxidant and it is the main polyphenolic acid.

- **Example:** *Imperata cylindrica*



26



2. Caffeic acid

- Caffeic acid is a well-known important phenolic substance found from plants and belongs to hydroxycinnamic acid derivatives
- Caffeic acid plays an essential role in inhibiting seed germination and seedling growth of some plants
- **Example:** Sunflower plants

