



Wrocław University
of Science and Technology



VALORIZATION OF POST-EXTRACTION BIOMASS RESIDUES AS CARRIERS OF BIOAVAILABLE MICRONUTRIENTS FOR PLANTS AND LIVESTOCK

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- *Grant “Crop plants and natural products as a source of biologically active substances for the manufacture of cosmetics, pharmaceuticals and dietary supplements” (BIOSTRATEG2/298205/9/NCBR/2016) by The National Centre for Research and Development in Poland.*

HERBS



Alfalfa (*Medicago sativa*)

Proteins
Vitamins
Flavonoids
Saponins
Phytosterols

- ✓ **Antimicrobial**
- ✓ **Anti-inflammatory**
- ✓ **Antioxidant compounds**

Polyphenols
Saponins
Anthocyanidins
Flavonoids



Application:

- ✓ Pharmaceutical
- ✓ Medicine
- ✓ Cosmetics
- ✓ Food
- ✓ Other



Goldenrod (*Solidago virgaurea L.*)

SEPARATION OF BIOLOGICALLY ACTIVE COMPOUNDS



- Rich in functional groups (carboxyl, hydroxyl, etc.)
- Such sorption potential of functional groups **must be** exploited for the production of new materials with **desirable properties**
- Good candidate for microelement carriers



Supercritical extraction with CO₂



Valuable compounds

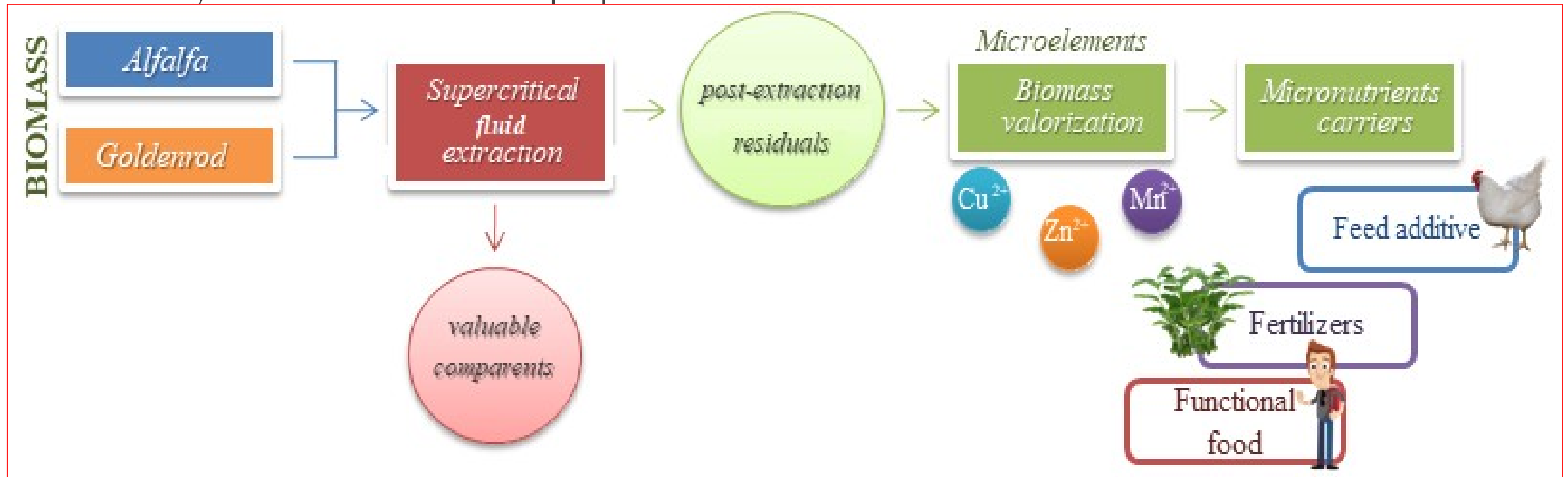


Waste post-extraction residues

WASTE MANAGEMENT!

VALORIZATION OF WASTE BIOMASS

- In line with the circular economy concept – waste-free
- Recovery of materials for other purposes



MICROELEMENTAL FERTILIZERS

Deficit of micronutrients in the soil:

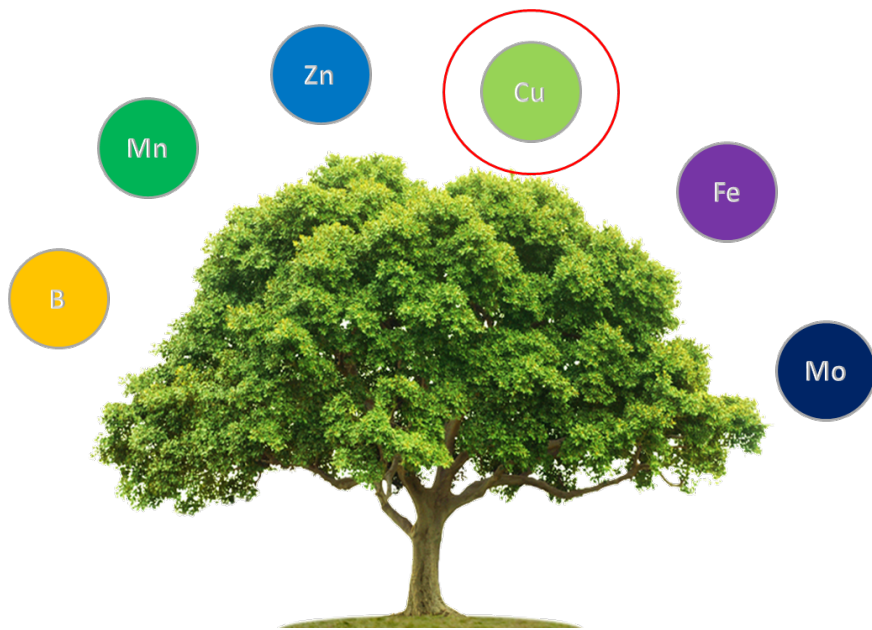
B: 60-75%

Cu: 40%

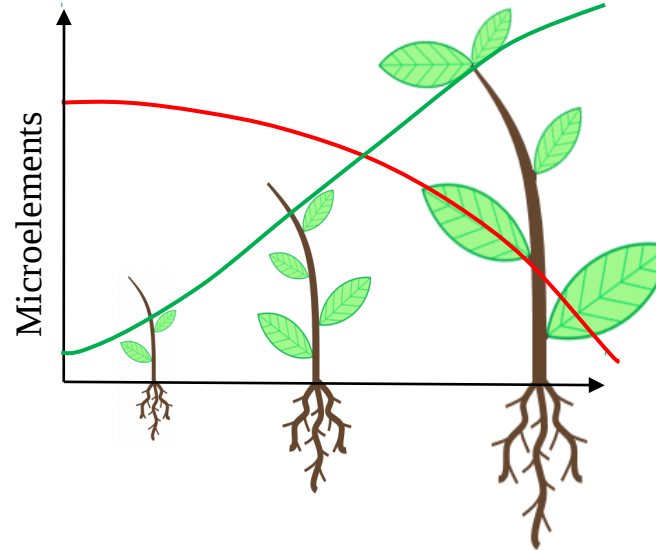
Mo: 20%

Zn: 10%

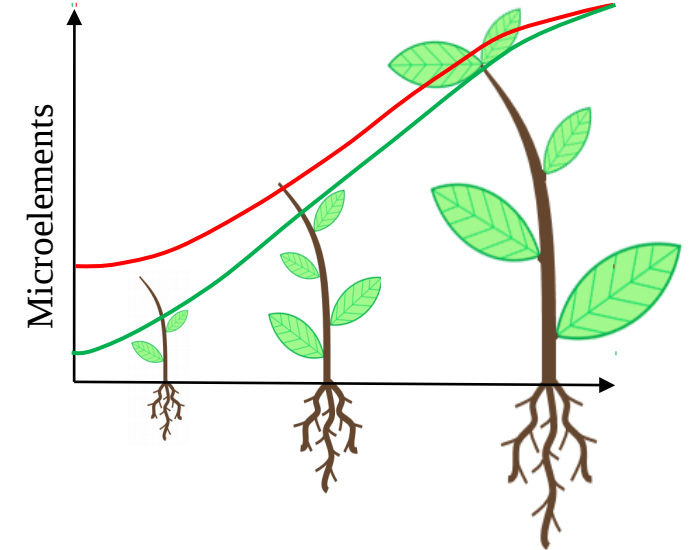
Mn: 10%



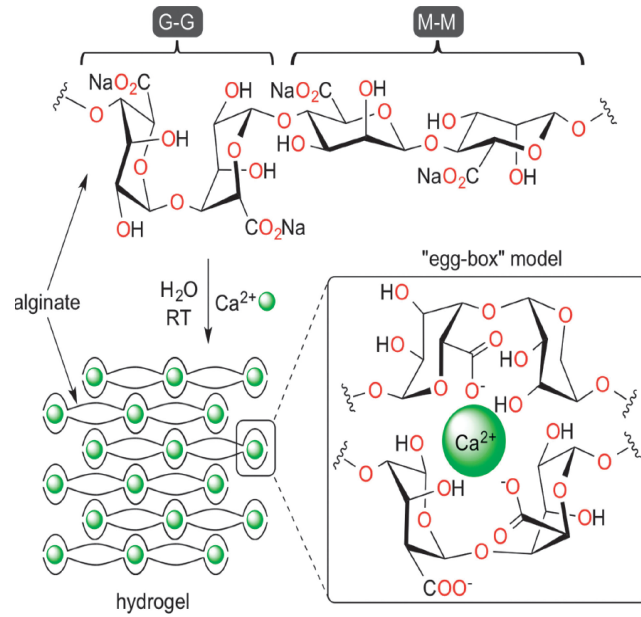
Traditional Fertilizers



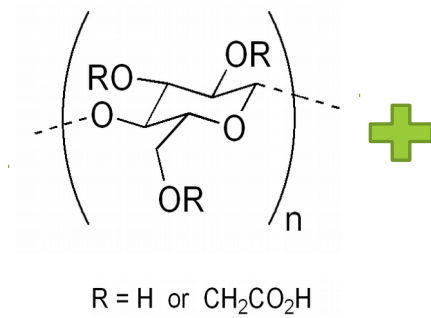
Slow Released Fertilizers



PREPARATION OF COMPOSITES FOR SLOW RELEASE OF MICRONUTRIENTS



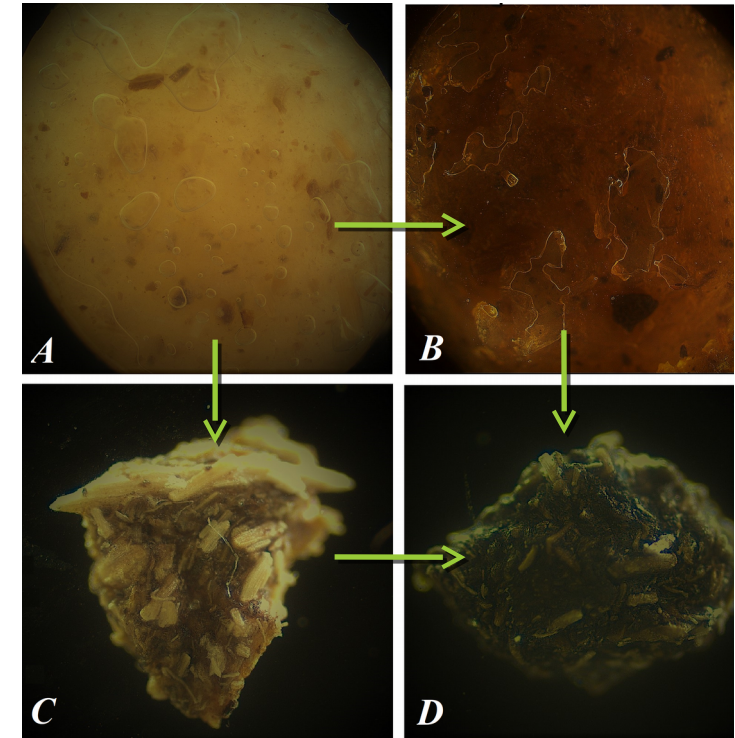
ALGINATE



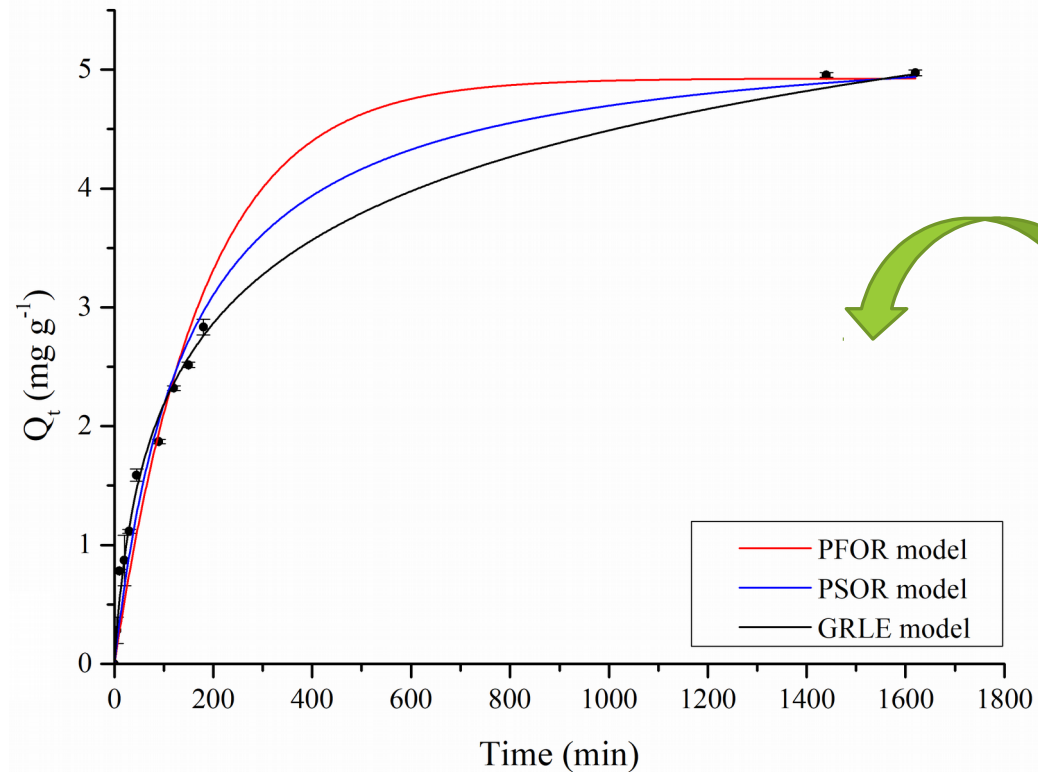
CMC



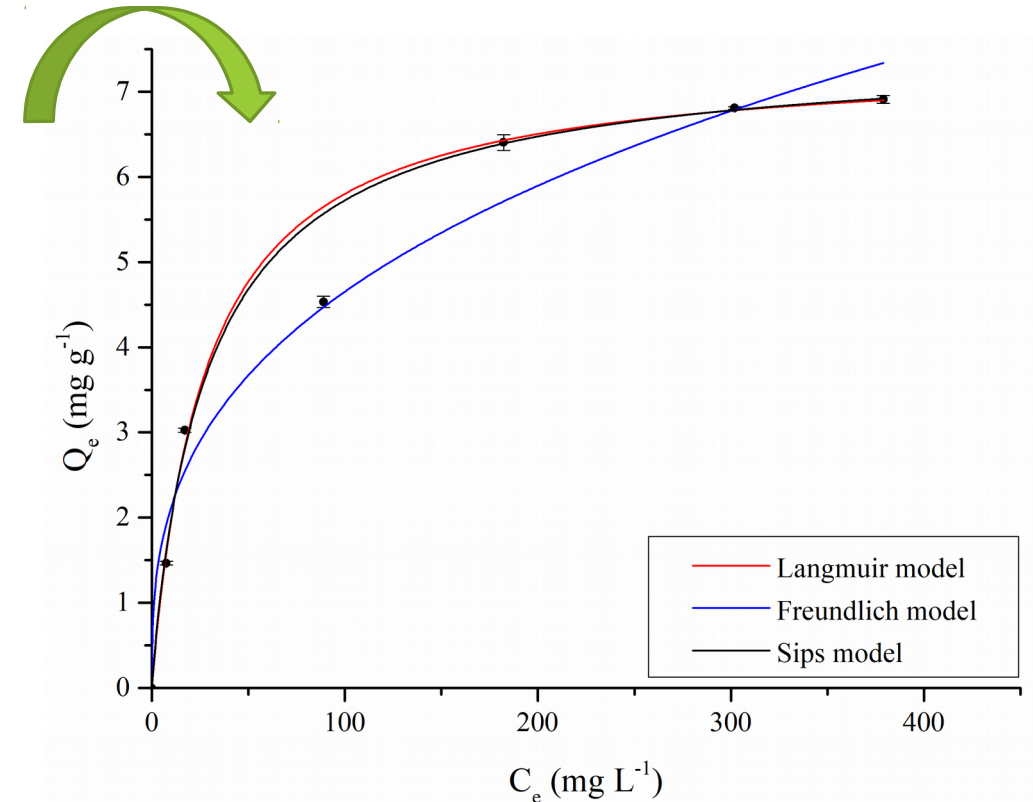
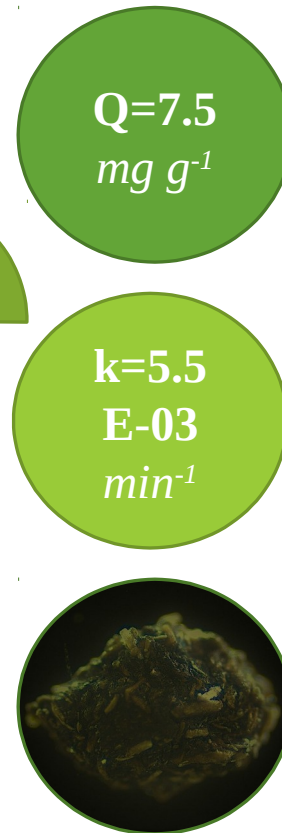
GOLDENROD



KINETICS AND EQUILIBRIUM OF Cu^{2+} IONS SORPTION

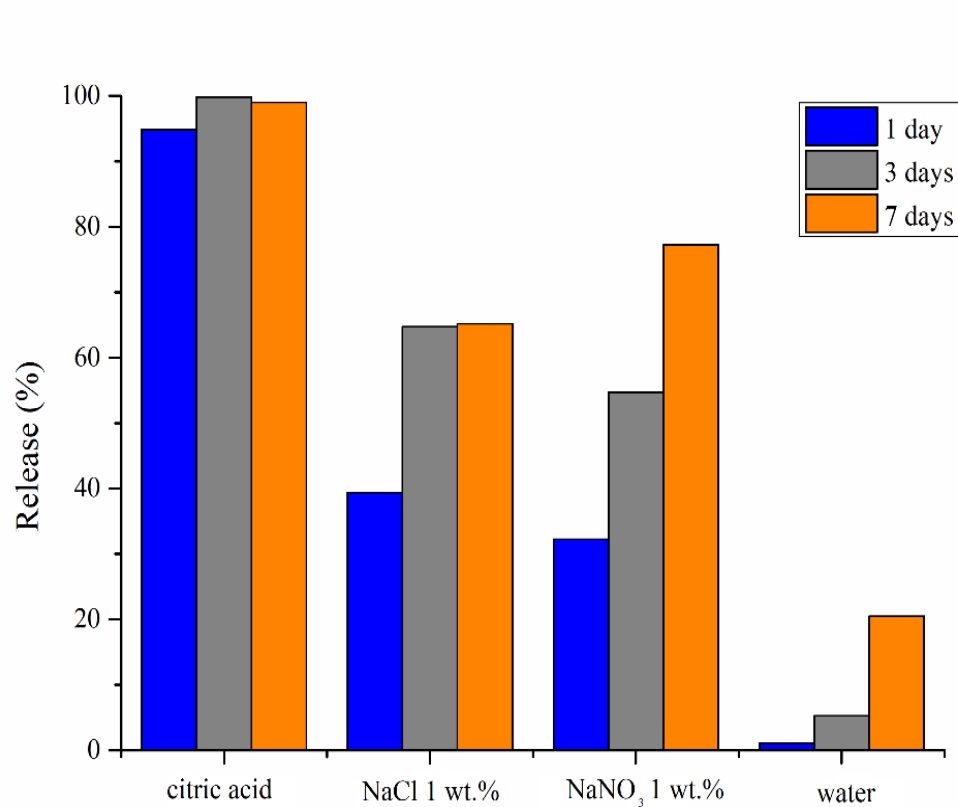


Kinetics of binding of Cu^{2+} for biocomposites: dashed line - PFORE, PSORE and GRLE ($T: 20^\circ\text{C}$; sorbent dosage 30 g L^{-1} ; contact time: 26 h; $\text{pH}: 5$)

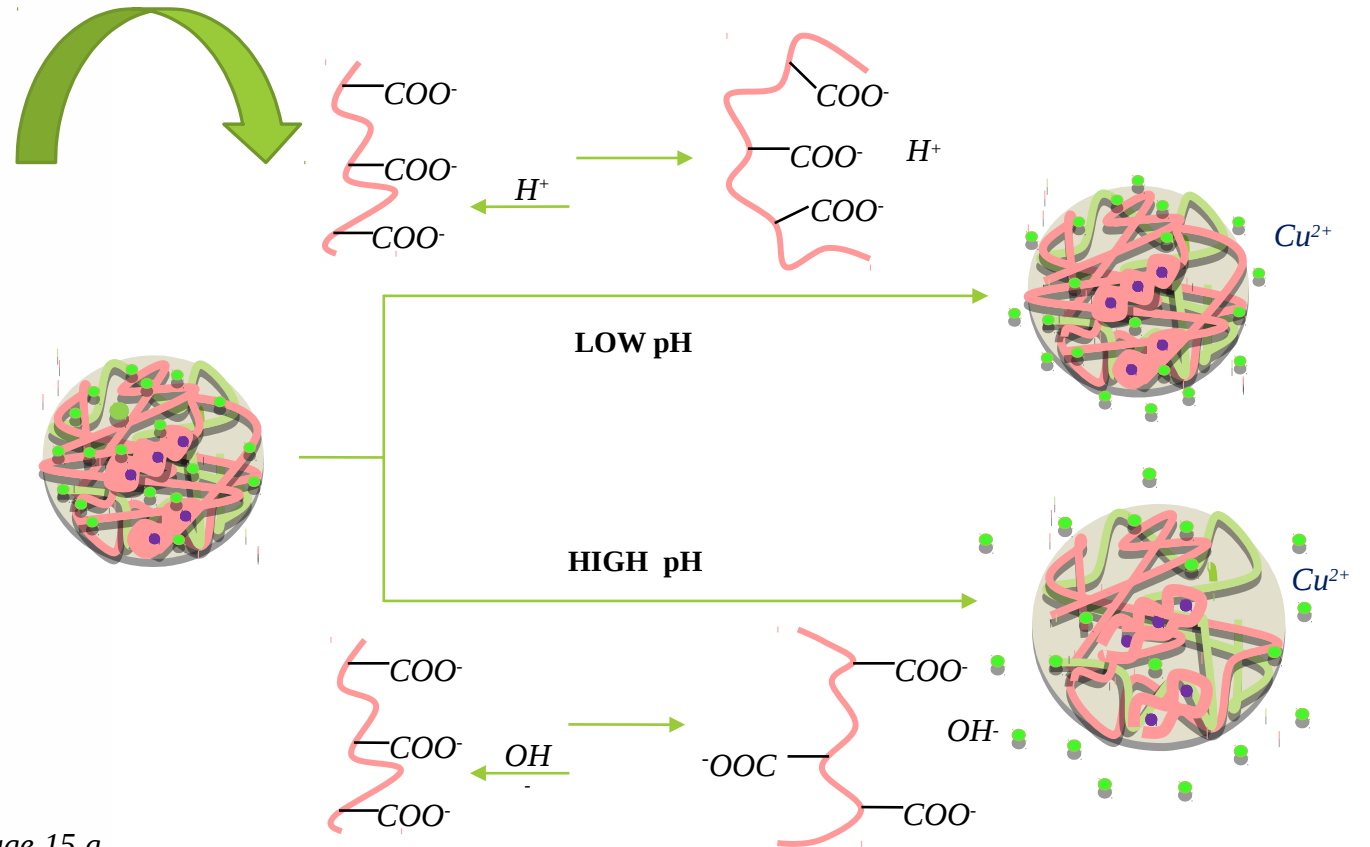


Equilibrium of binding of Cu^{2+} ions for biocomposites: (dashed line: Langmuir, Freundlich and Sips model; $T: 20^\circ\text{C}$; sorbent dosage: 30 g L^{-1} , contact time: 24 h; $\text{pH}: 5$; C_0 : $50 - 500 \text{ mg L}^{-1}$)

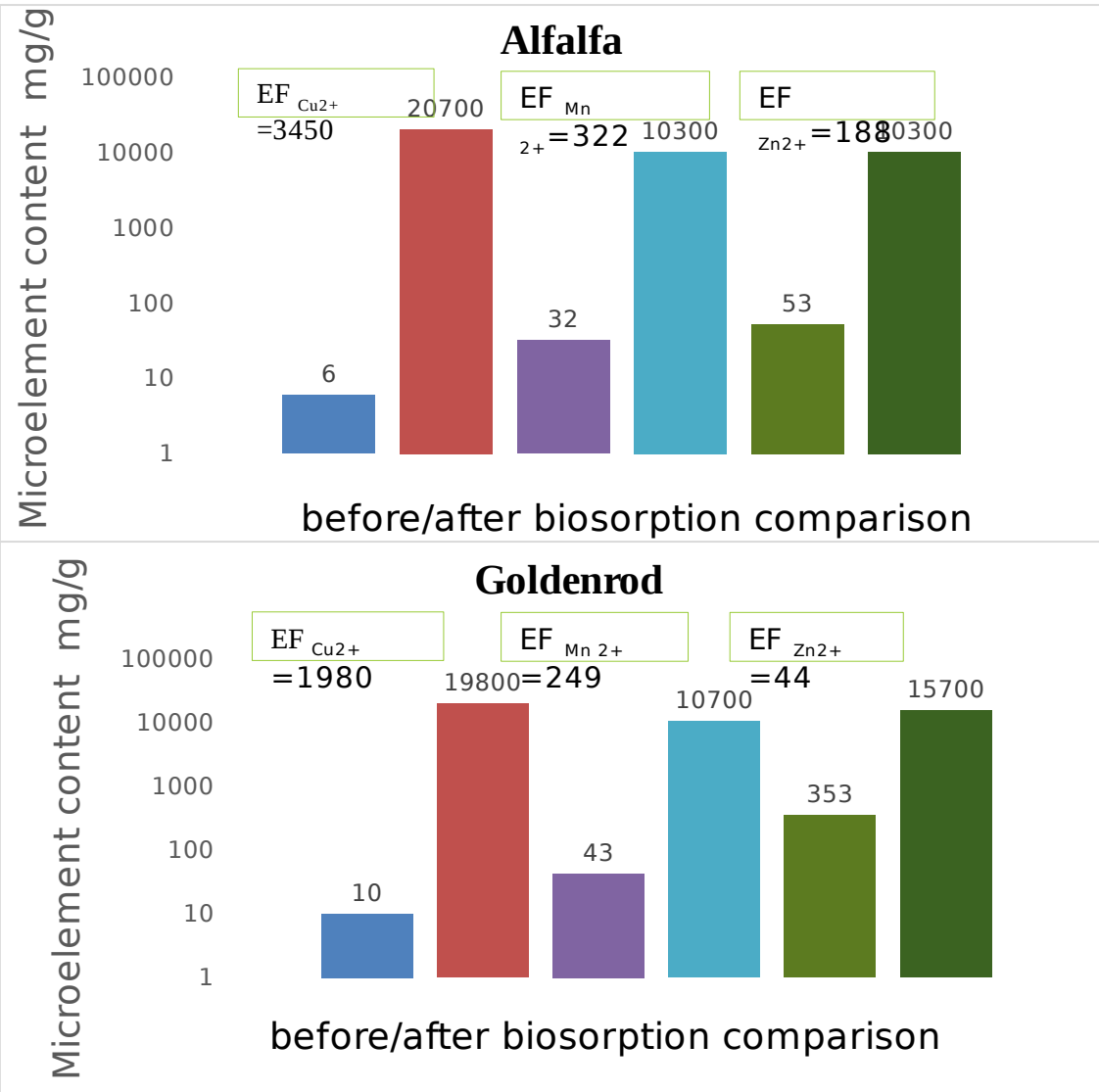
RELEASE OF Cu^{2+} IN VARIOUS MEDIA



Release of Cu^{2+} ions in various media for biocomposites ($T: 20^\circ\text{C}$; sorbent dosage 15 g L^{-1} ; contact time: 7 days; media: aqueous solution of citric acid 0.1M, NaCl 1 wt.%, NaNO₃ 1 wt.% and water)



FEED ADDITIVES WITH MICROELEMENTS



Quarter-technical scale

DESORPTION EXPERIMENT

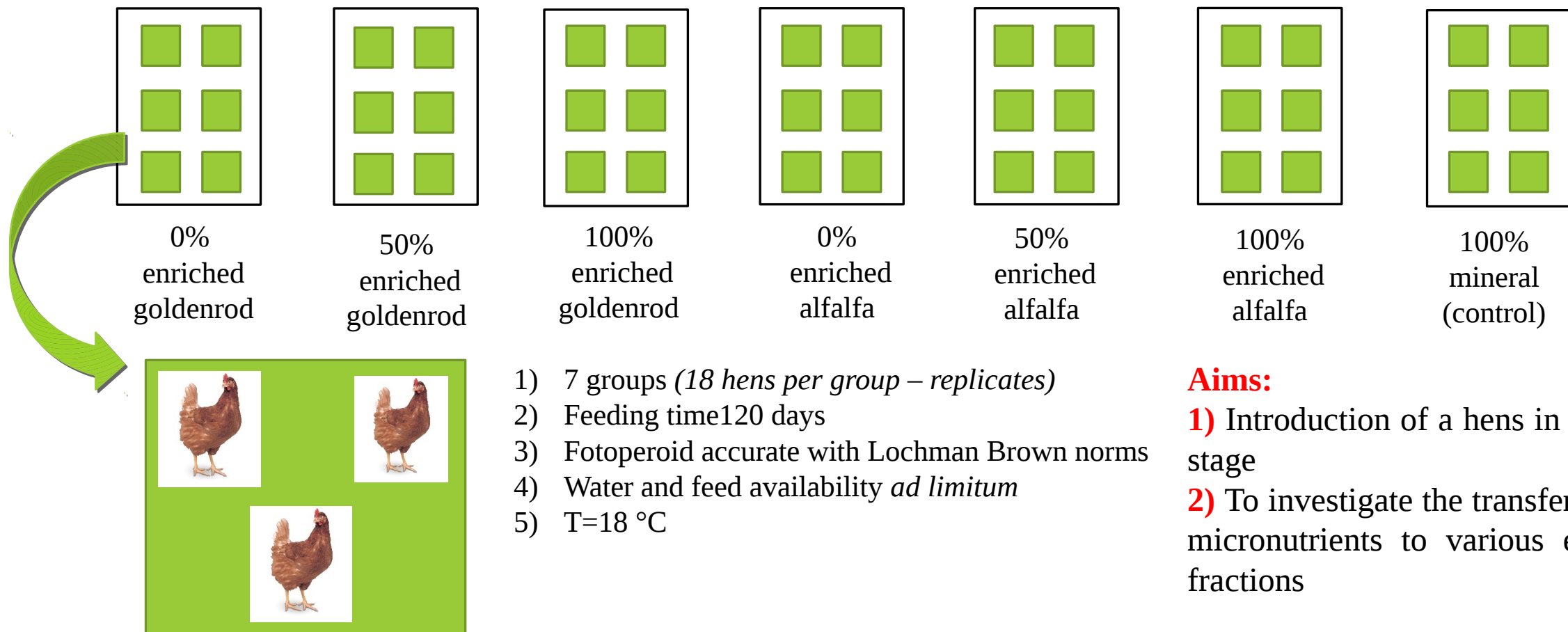
pH	Cu ²⁺	Zn ²⁺	Mn ²⁺
1	9,80	18,99	16,52
7	1,27	5,68	4,72
11	0,78	3,32	1,61

Desorption rate (%) of microelements
form **alfalfa** based feed additives in
aqueous solution.

pH	Cu ²⁺	Zn ²⁺	Mn ²⁺
1	14.39	26,86	21,89
7	5,49	5,76	5,92
11	0,10	1,15	0,91

Desorption rate (%) of microelements
form **goldenrod** based feed additives
in aqueous solution.

APPLICATION EXPERIMENT DESIGN



group	time [days]	ION CONTENT [µg]		
		Cu ²⁺	Mn ²⁺	Zn ²⁺
0% enriched alfalfa	30	34,18	34,18	464,71
	60	18,79	12,1	515,26
	90	21,1	13,63	494,52
50% enriched alfalfa	30	34,06	34,06	582,31
	60	28,73	14,94	617,7
	90	23,87	14,79	644,81
100% enriched alfalfa	30	40,39	40,39	456,22
	60	21,13	13,49	542,5
	90	20,03	13,18	599,25
0% enriched goldenrod	30	31,38	31,38	495,22
	60	23,84	17,08	594,53
	90	18,36	11,34	573,08
50% enriched goldenrod	30	36,48	36,48	526,03
	60	21,79	15,37	576,65
	90	20,61	13,23	575,99
100% enriched goldenrod	30	28,59	28,59	448,01
	60	22,65	11,82	608,79
	90	35,37	15,78	743,43
100% mineral (control)	30	38,53	38,53	507
	60	20,35	15,46	573,97
	90	26,64	24,91	620,08

TRANSFER OF MICROELEMENTS TO EGG YOLK

The best micronutrient transfer was achieved for enriched goldenrod (32% more copper ions and 20% more zinc ions) after 120 days of feeding. The presence of competing ions significantly reduced the assimilation of manganese ions.



group	time [day]	HU	±SD
0% enriched alfalfa	30	91,33	8,62
	60	83,33	5,69
	90	83,67	6,51
50% enriched alfalfa	30	72,33	7,64
	60	85,33	5,69
	90	90,33	8,50
100% enriched alfalfa	30	85,00	7,21
	60	75,67	3,06
	90	87,00	8,54
0% enriched goldenrod	30	88,33	3,21
	60	83,00	5,29
	90	90,33	7,64
50% enriched goldenrod	30	79,33	6,66
	60	86,33	6,11
	90	88,67	4,16
100% enriched goldenrod	30	77,67	4,04
	60	81,00	8,89
	90	77,00	4,58
100% mineral (control)	30	90,67	5,03
	60	79,00	8,89
	90	85,00	3,00

HAUGH UNIT

Haugh Index :

AA : 72 or more

A : 71 - 60

B : 59 - 31

C : 30 or less



CONCLUSIONS



1. Alfalfa and goldenrod are good carriers of microelements for fertilizing purposes and as feed additives.
2. Fertilizers with the addition of goldenrod closed in a hydrogel matrix are characterized by a slow release of micronutrients to the environment.
3. Transfer of micronutrients to yolk was significant.
4. All groups of eggs obtained the AA group of quality - the highest in a given class