

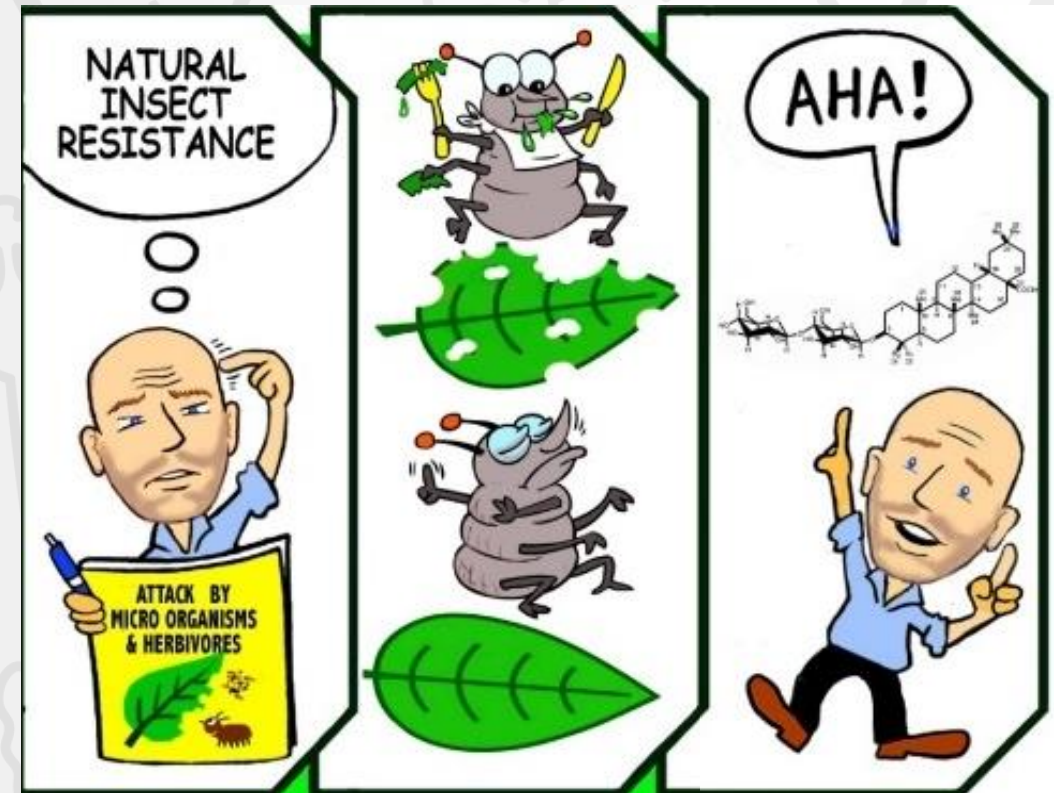
Saponiner – fremtidens naturlige biopesticider

Søren Bak

Institut for Plante- og Miljøvidenskab
Københavns Universitet



KØBENHAVNS UNIVERSITET



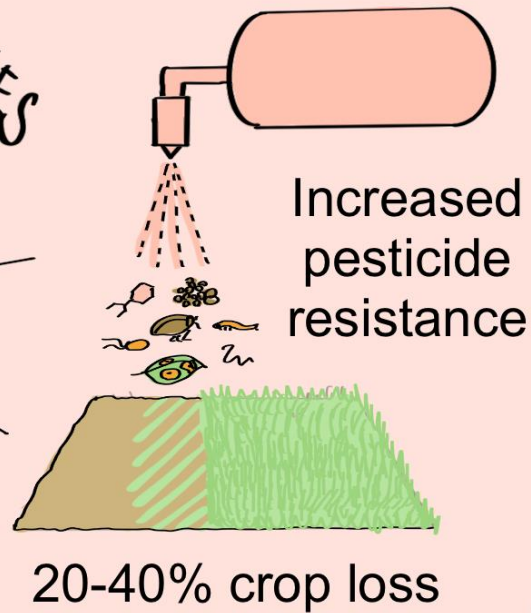
Naturen skal lære os, hvordan vi bæredygtigt kan forsvare afgrøder

Har saponiner et potentiale som fremtiden plantebeskyttelsesmidler til bæredygtigt landbrug til gavn for samfund, miljø og folkesundhed?

RELEVANCE



TODAY

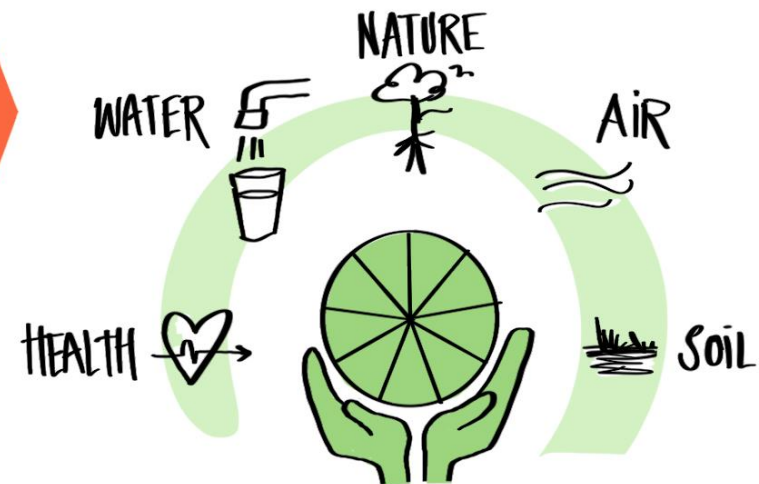


2030

EU Green Deal
50% pesticide
reduction

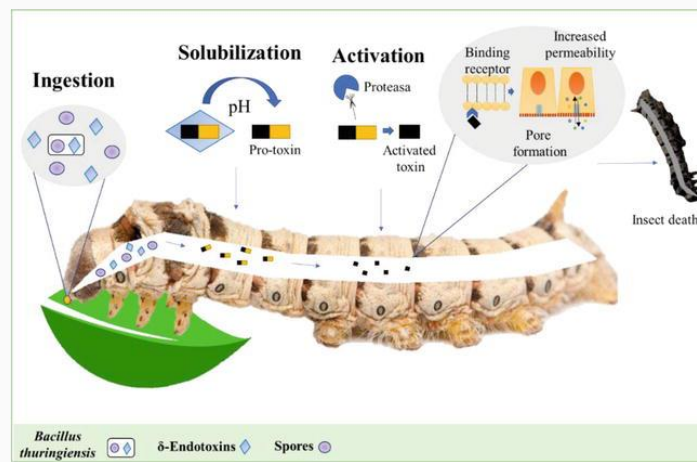
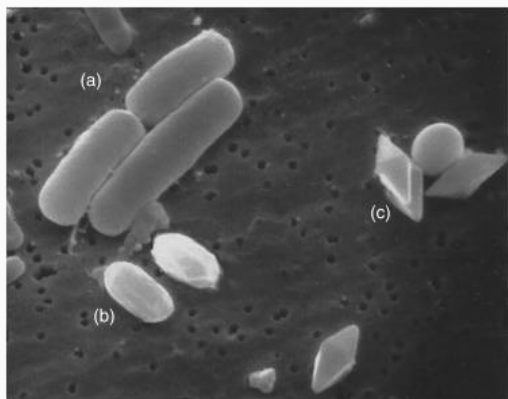
2050

Zero pollution
Planet in balance



Hvad er et biopesticid?

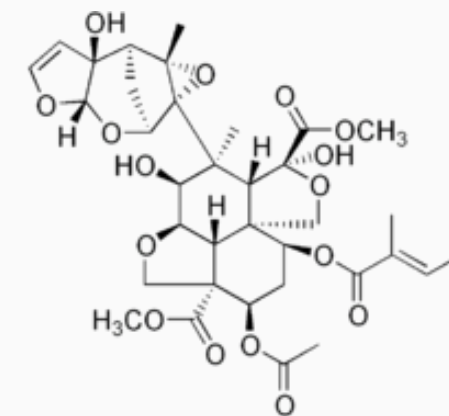
- En undergruppe af pesticider typisk afledt af planter og mikroorganismer.
- Er virksomme mod skadedyr, sygdomme og ukrudt.
- Er mere miljøvenlig end konventionelle pesticider.
- Er mindre skadelige for mennesker og ikke-målorganismer.
- Ofte del af integreret bekæmpelsesstrategier (IPM).



BT krystaller aktiveres i larvers alkaliske tarm.



Olie fra Neem træet som et afskrækningsmiddel mod fødeindtag .

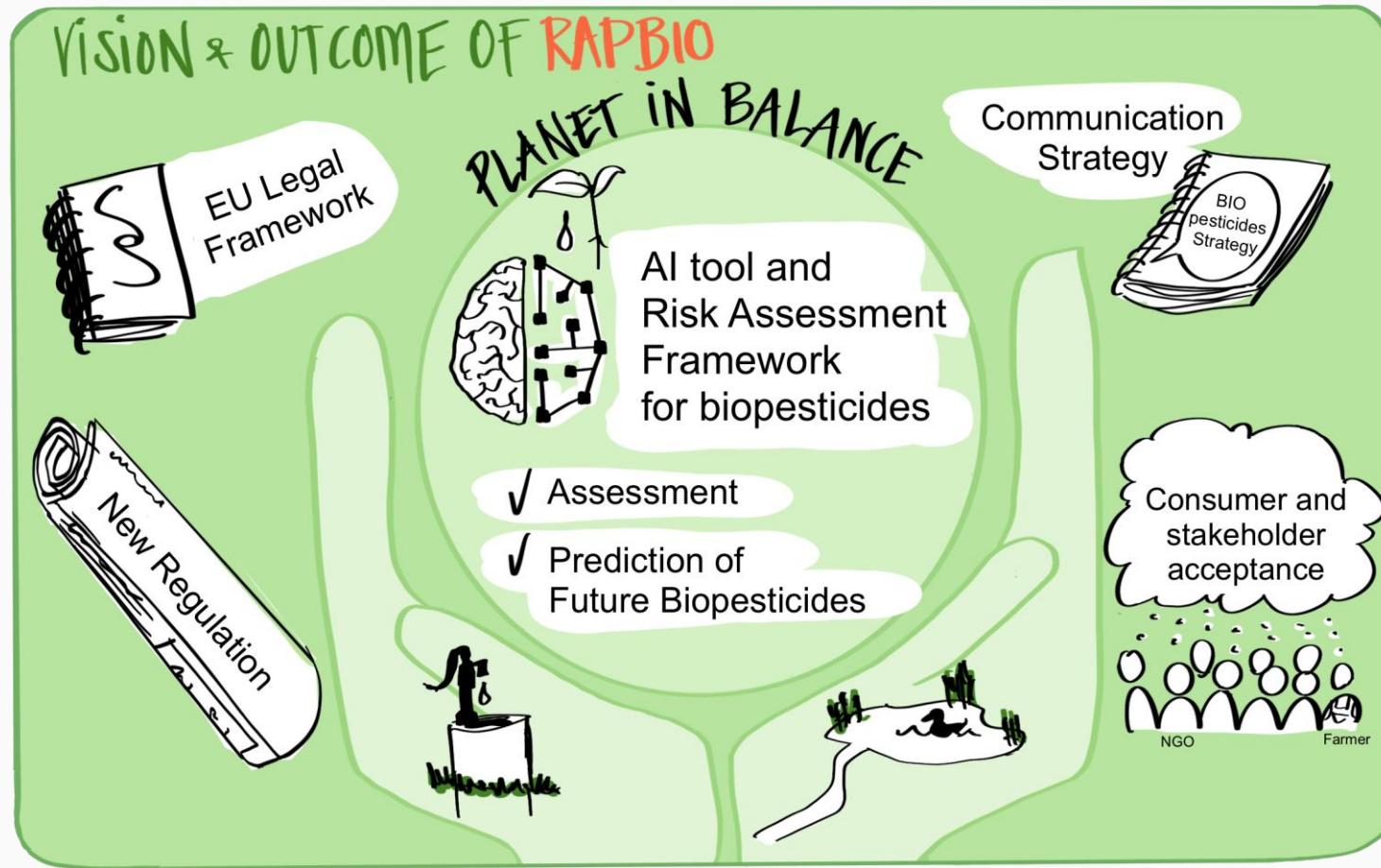


Nogle barrierer for introduktion af plantebaseret biopesticider.

Værktøjer til risikovurdering

Lovgivning

Innovationsbarriere



Kommunikation

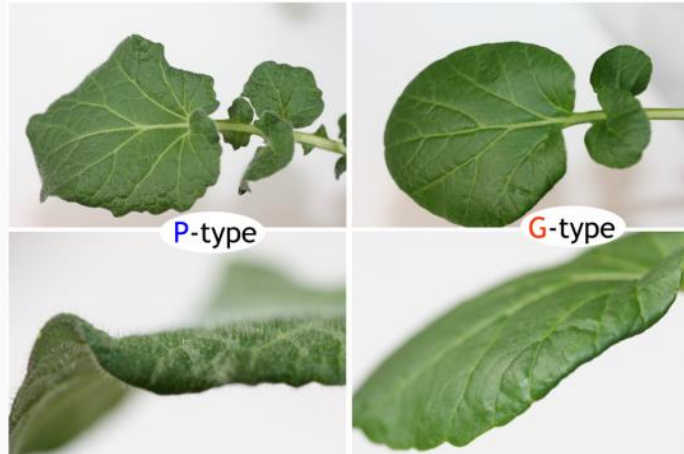
Social accept

Miljøevaluering

Hvorfor er nogle typer af vinterkarse **resistente** overfor insektangreb mens andre er **modtagelige**?



Barbarea vulgaris
(vinterkarse)



Pubescent
modtagelige

Glabrous
resistente



Phyllotreta nemorum
(jordloppe)



Plutella xylostella
(kålmøl)

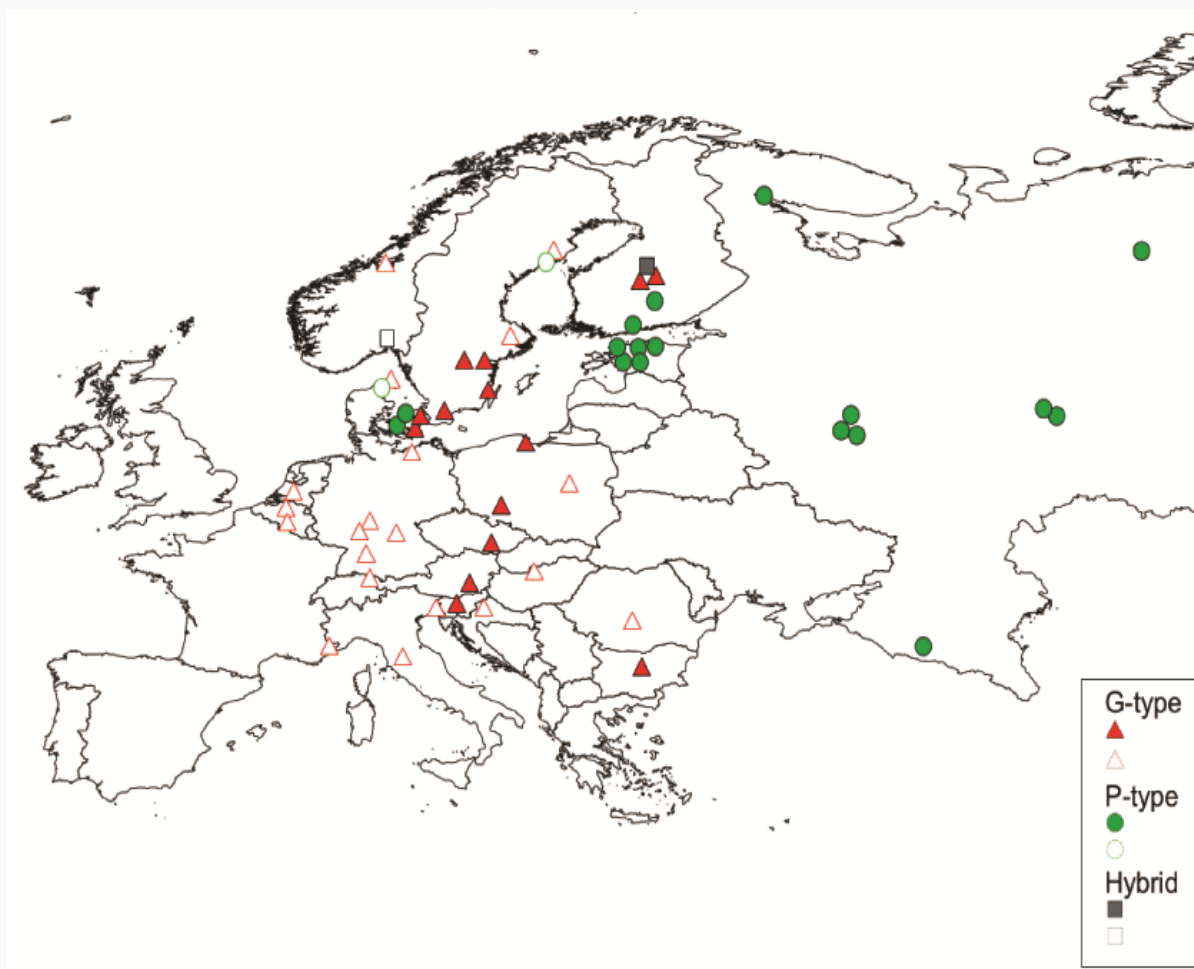


Pieris rapa
(kålsommerfugl)



Forskellig geografiske udbredelser af vinterkarse – måske pga geografisk adskillelse under istiden.

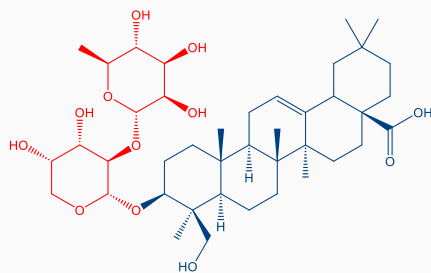
G-type
(Glabrous - resistant)



P-type
(Pubescent - modtagelig)



Saponiner er udbredte bioaktive stoffer i planter (>100 plante familier)



Saponin struktur bestemmer deres (bio)aktivitet



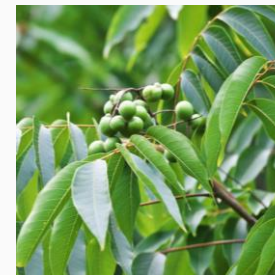
Babarea vulgaris – Vinterkarse



Saponaria off. – Sæbeurt



Sapindus mukorossi – Sæbebær



Chenopodium quinoa - Quinoa



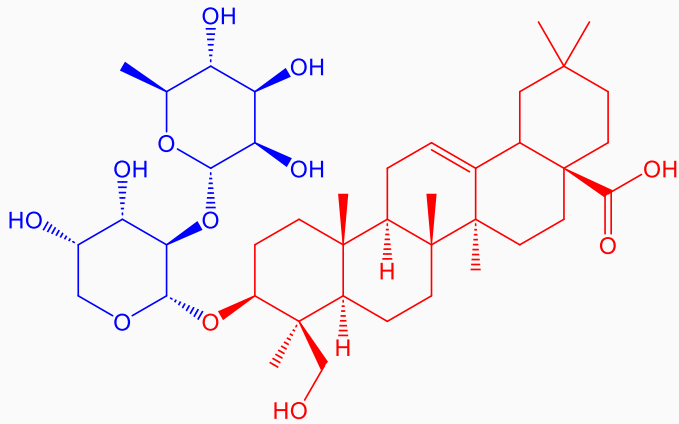
Hedera helix – Have efeu



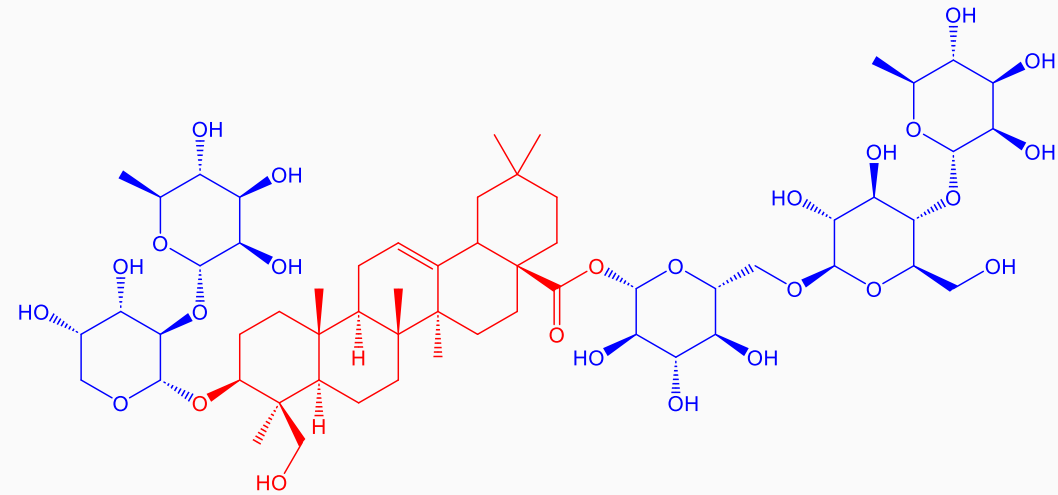
Aesculus hippocastanum - Kastanje



Saponiner er naturligt forekommende detergenter (sæber).



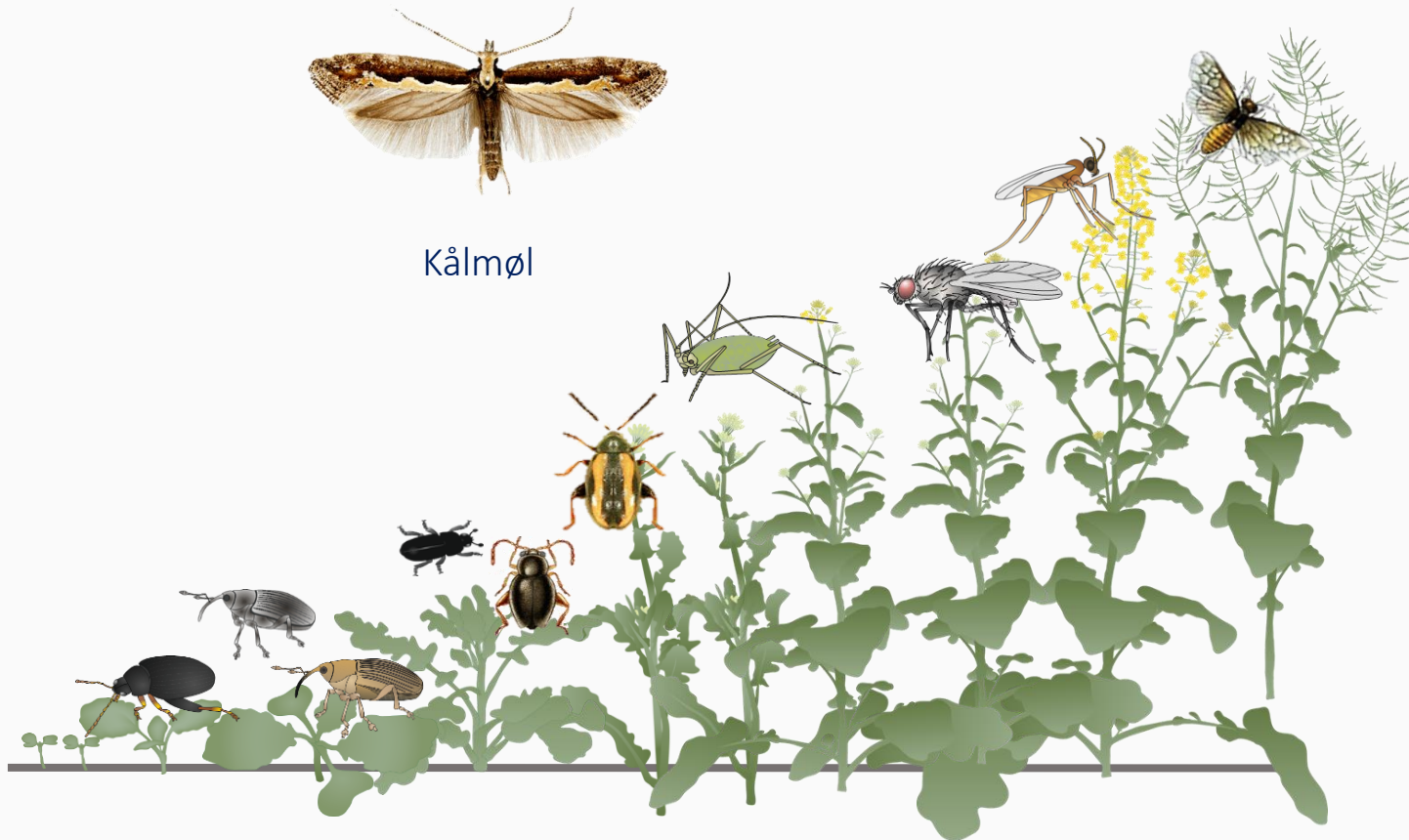
Monodesmosidic
 α -Hederin



Bidesmosidic
Hederacoside C



Kålmøl er et stort problem i korsblomstrede afgrøder



Kålmøl

Fakta box

- Larver skader bladene
- Resistent mod over 91 insekticider
- Årlig globale omkostning ~ 36 mia. kr.



Kålmøl larver

Saponiner fra Vinterkarse giver resistens mod Kålmøl

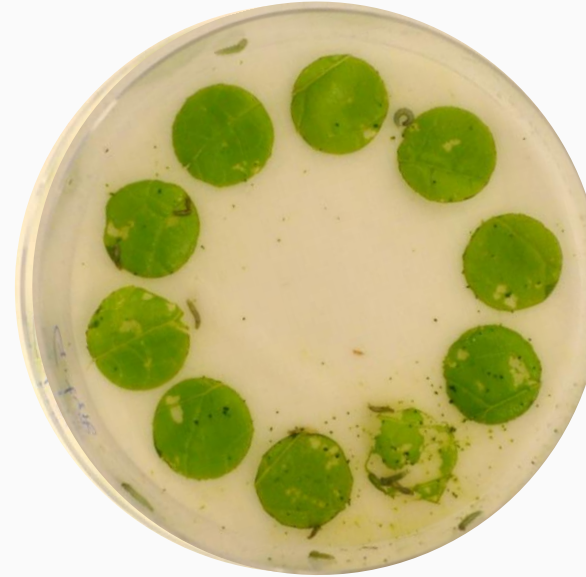


Kålmøl

Kontrol-
behandling



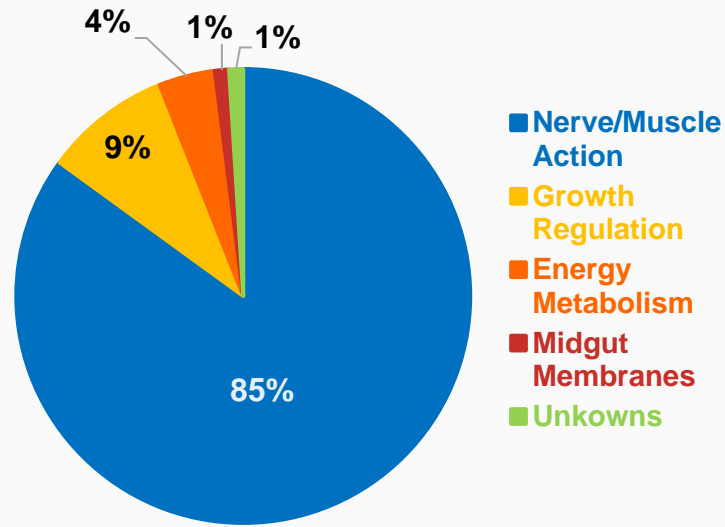
Behandling med
vinterkarse ekstrakt



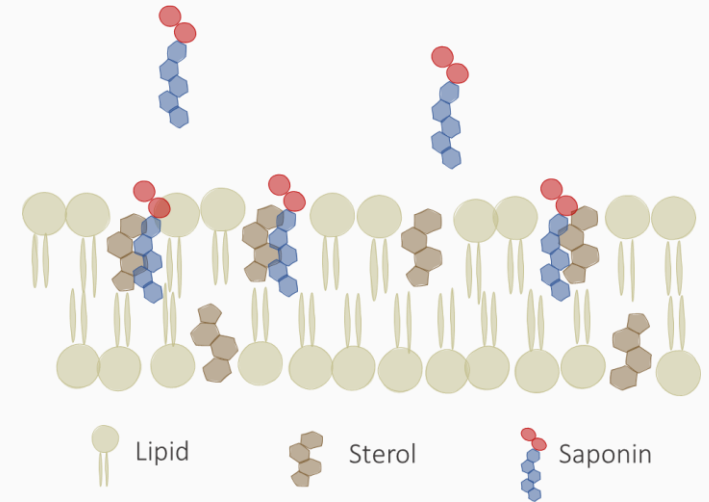
Vinterkarse

Forskellen mellem Saponiner og syntetiske pesticiders virkemåde

- Insektdræbende
- Svampedræbende
- Antibakteriel
- Sneglebekæmpelse
- Ormebekæmpelse



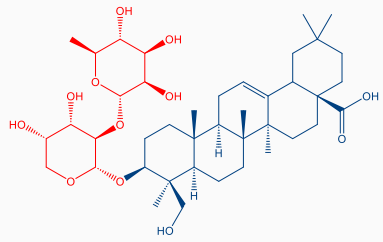
Pesticiders virkemåde



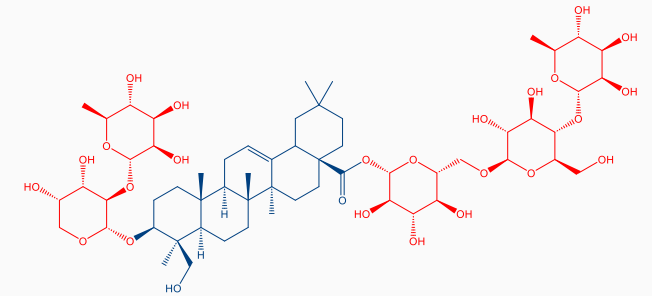
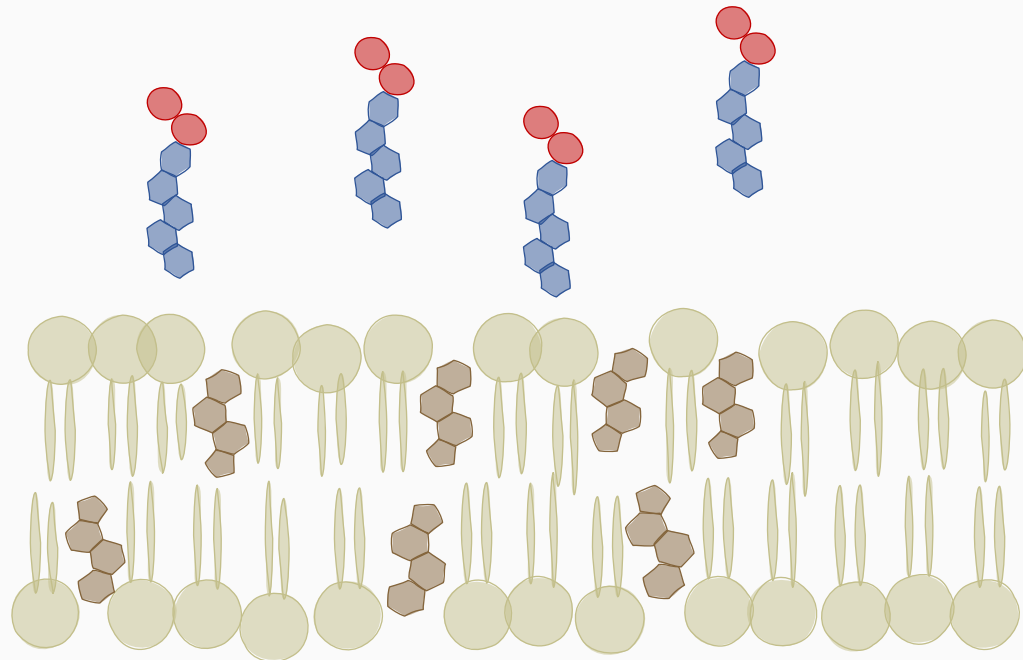
Saponiners virkemåde



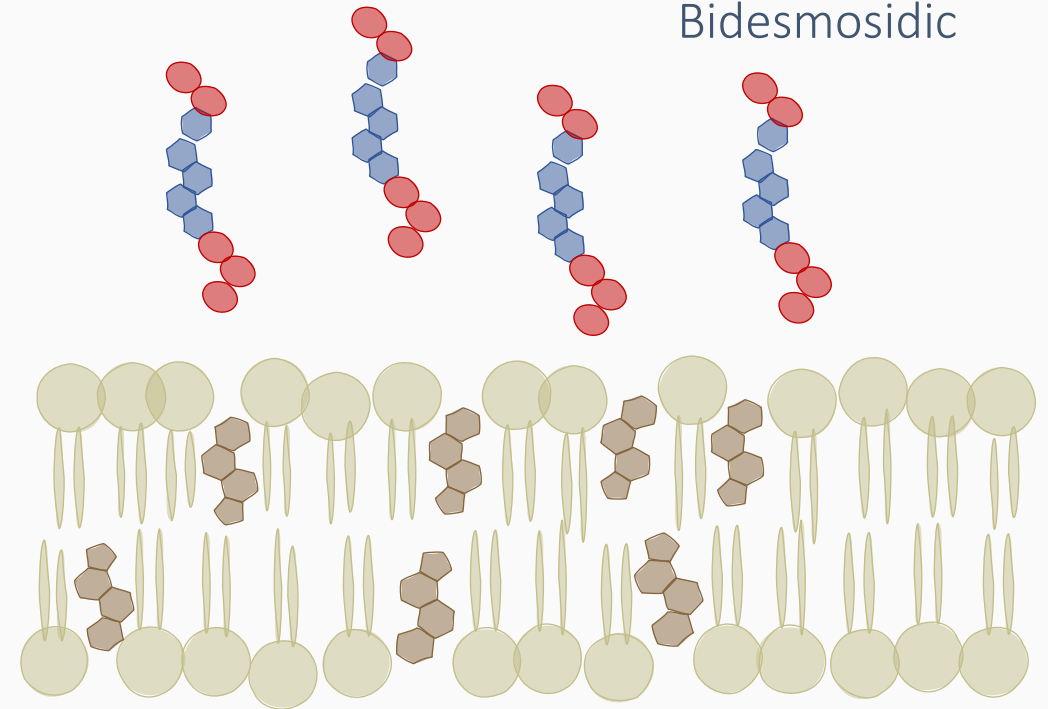
Ny model for Saponin-Sterol Interaktion



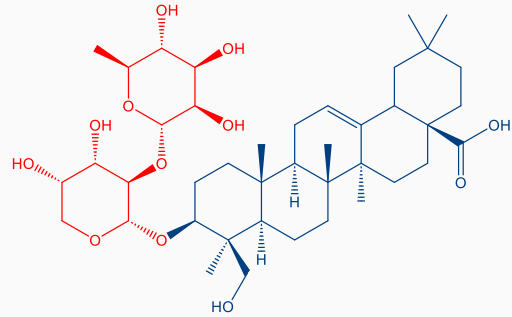
Monodesmosidic



Bidesmosidic

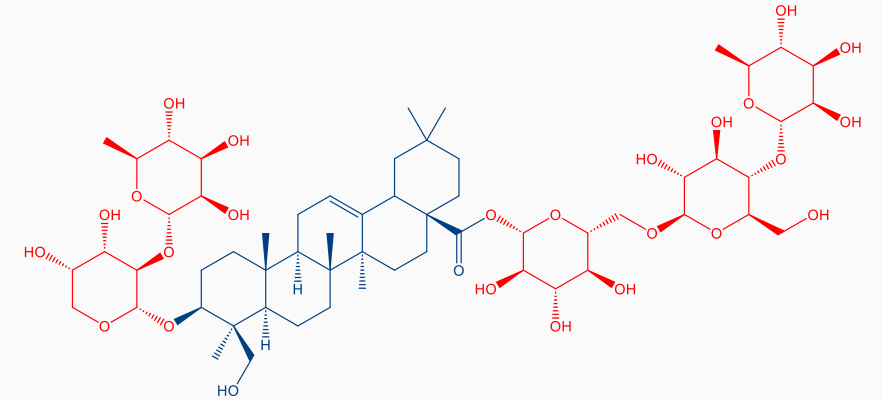


Ny model for Saponin-Sterol Interaktion



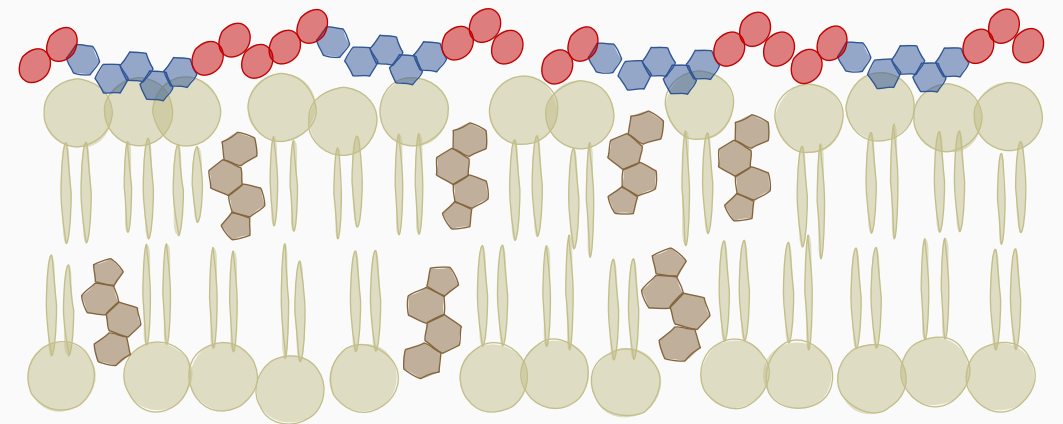
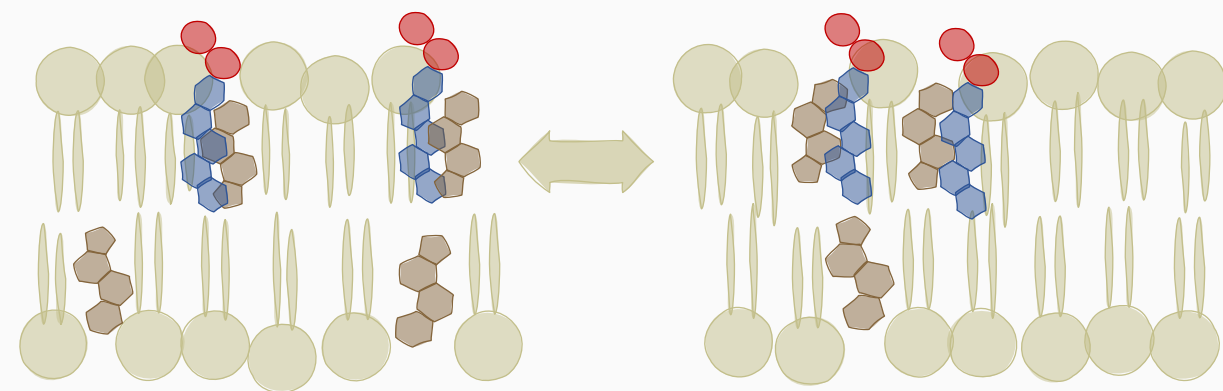
Monodesmosidic

Membrane deterioration



Bidesmosidic

Membrane preservation



Lipid Sterol Saponin

Oprendsning af saponiner – laboratorie skala



Plant material



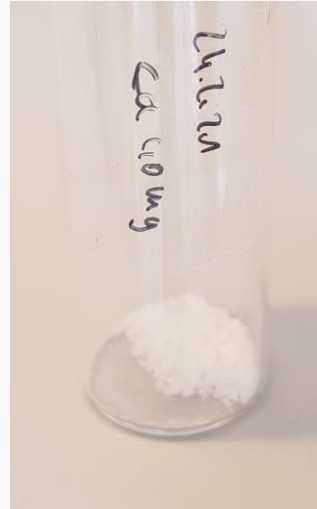
PuriFlash 5.250



LC-qToF-MS/MS



NMR



40mg α -Hederin from 5g DW *Hedera helix* leaves



Saponins from *Hedera helix* fruits



Saponins from *Chenopodium quinoa*



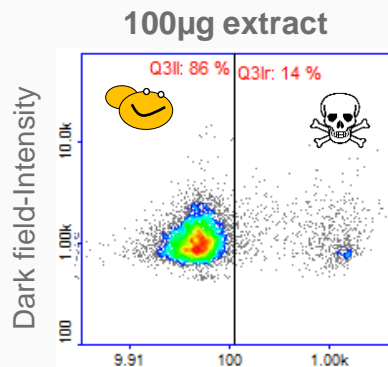
Saponins from *Quillaja saponaria*



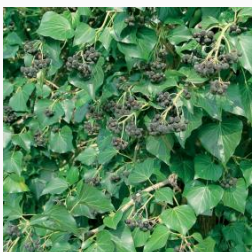
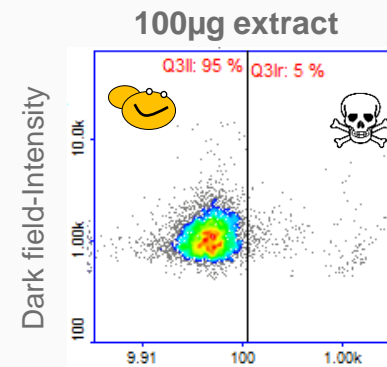
Effekt at forskellige saponin ekstrakter mod gær.



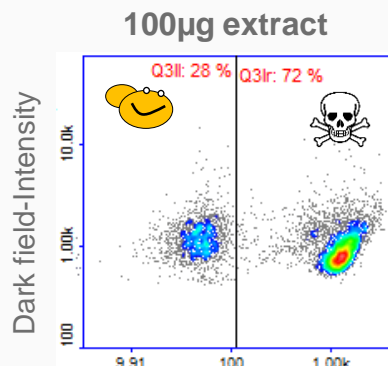
Hedera helix
Leaves



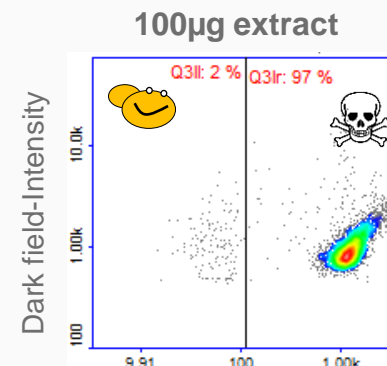
Chenopodium quinoa



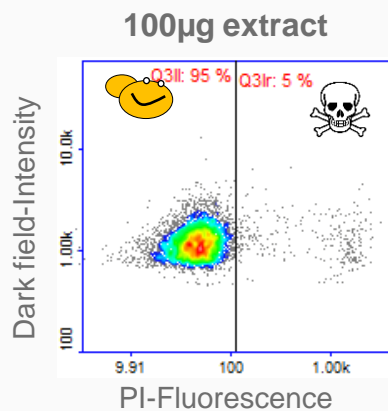
Hedera helix
Fruits



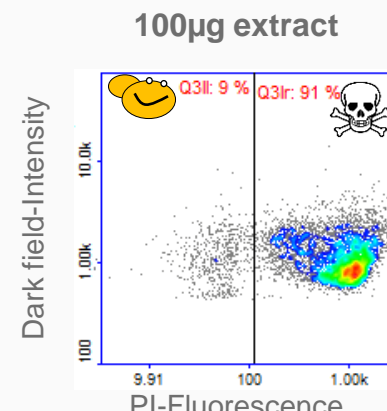
Sapindus mukorossi



Quillaja saponaria



Camellia sinensis



Oprendsning af saponiner fra sæbebær – pilot skala



Care by Nature

Opskalering fra biomasse - fremtiden



Plant material



Hedera Helix
4-6% dry weight



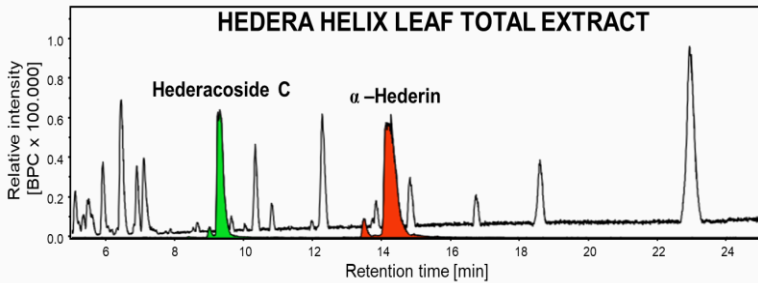
Barbarea vulgaris
0.5% dry weight



Chenopodium quinoa
A major biowaste in South America
10-20% saponin in the bran



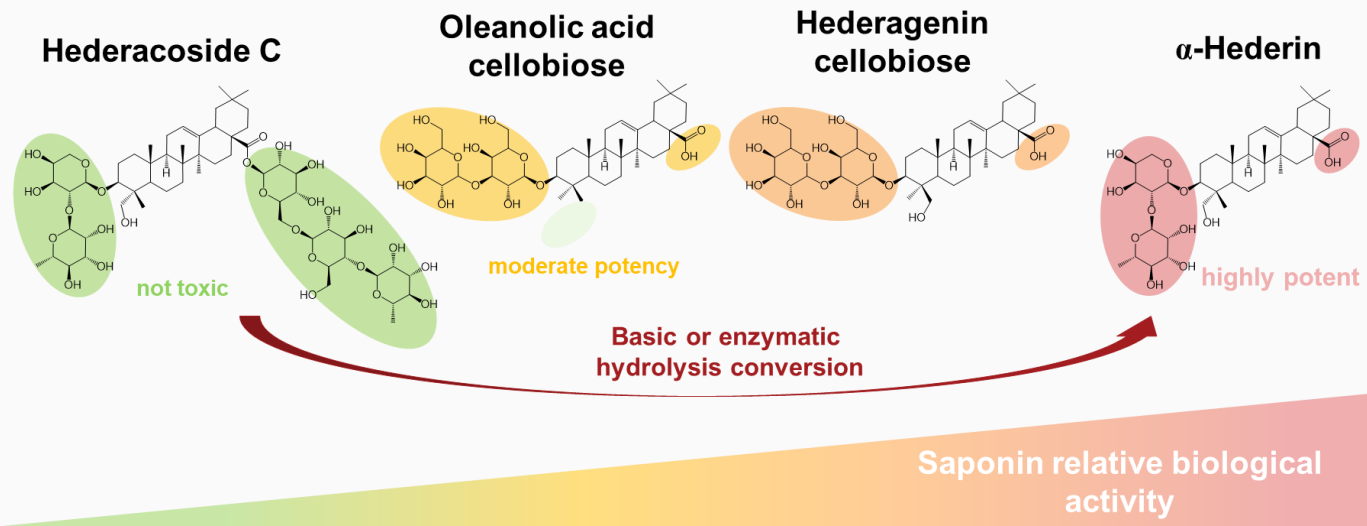
Chenopodium album
Weed that can be cultivated in DK



Plant extract



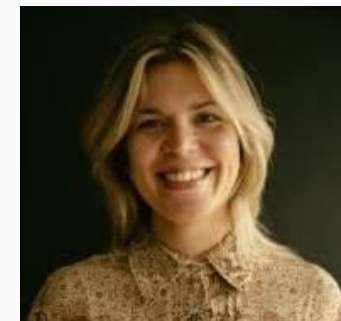
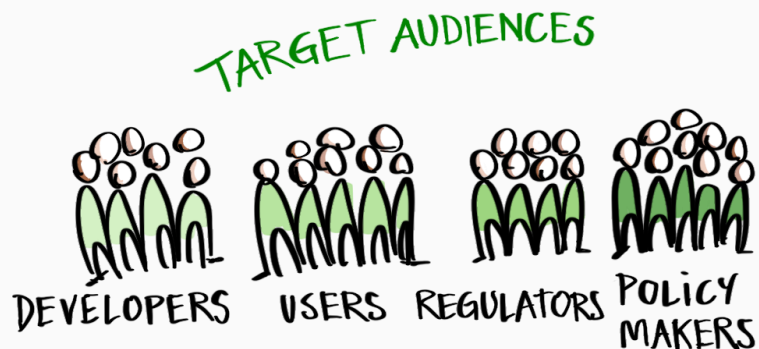
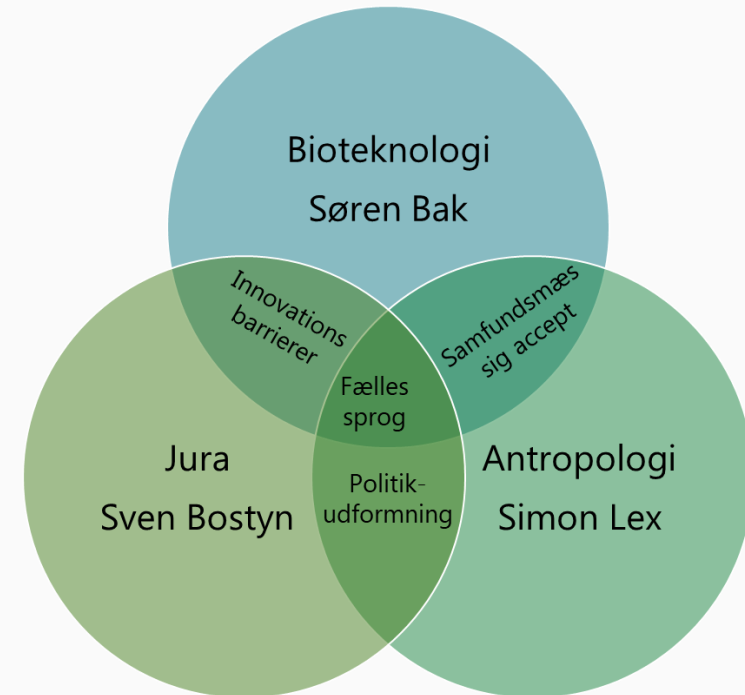
Purified saponin compound



Toksicitet af saponin

Hvad ser I af barrierer og muligheder for introduktion af biopesticider?

- Social accept eller bekymring?
 - Brugere – forbrugere – lovgivere – producenter
- Risikovurdering?
- Lovgivning?
- Innovation?
- Kommunikation?
- ?



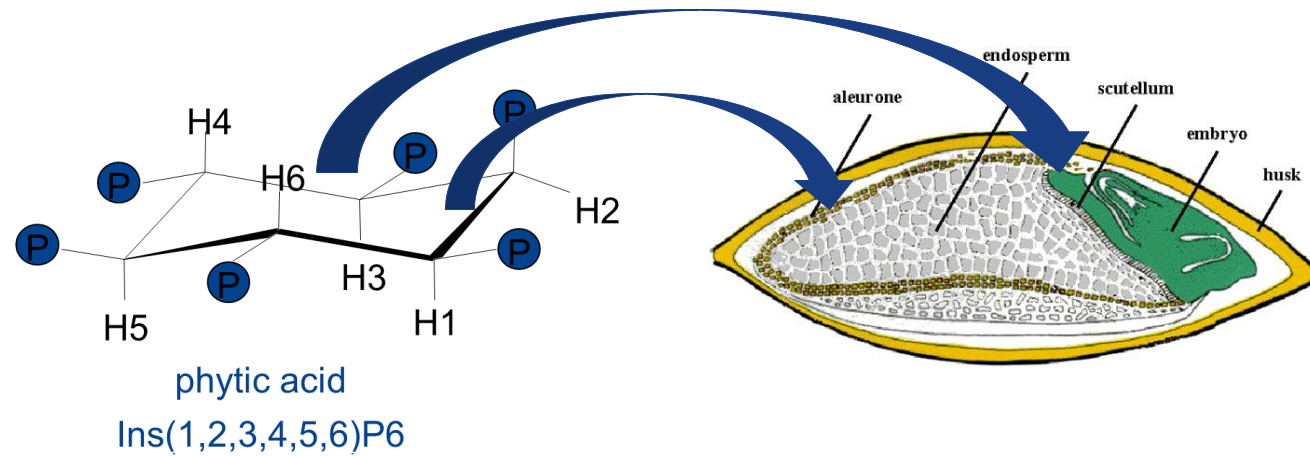
Šeila Božićev

NYE RESISTENTMULIGHEDER MOD FUSARIUM

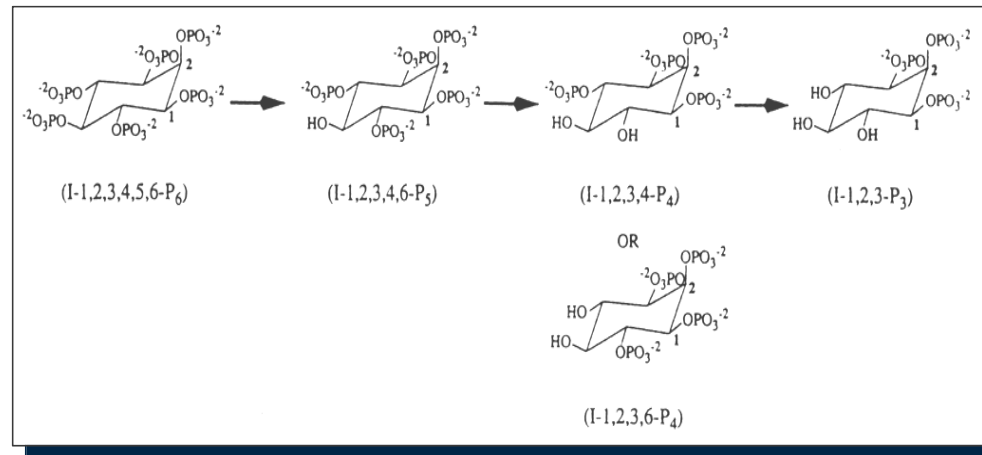
Henrik Brinch-Pedersen
Institut for Agroøkologi,
Sektion for Afgrøde Genetik og Biotechnologi



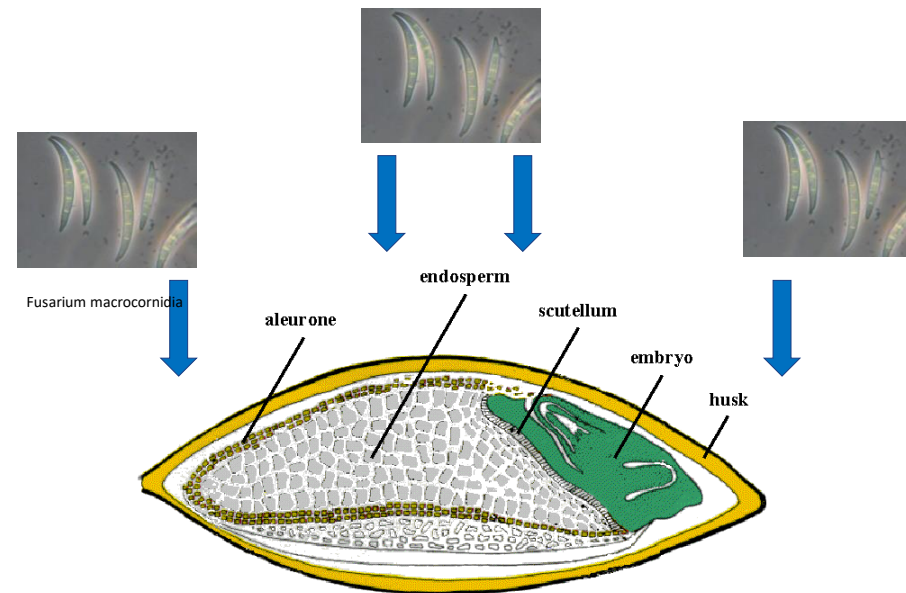
NY RESISTANS IMOD FUSARIUM: NEP BASERET RESISTENS



Fytinsyre nedbrydes af enzymet
fytase

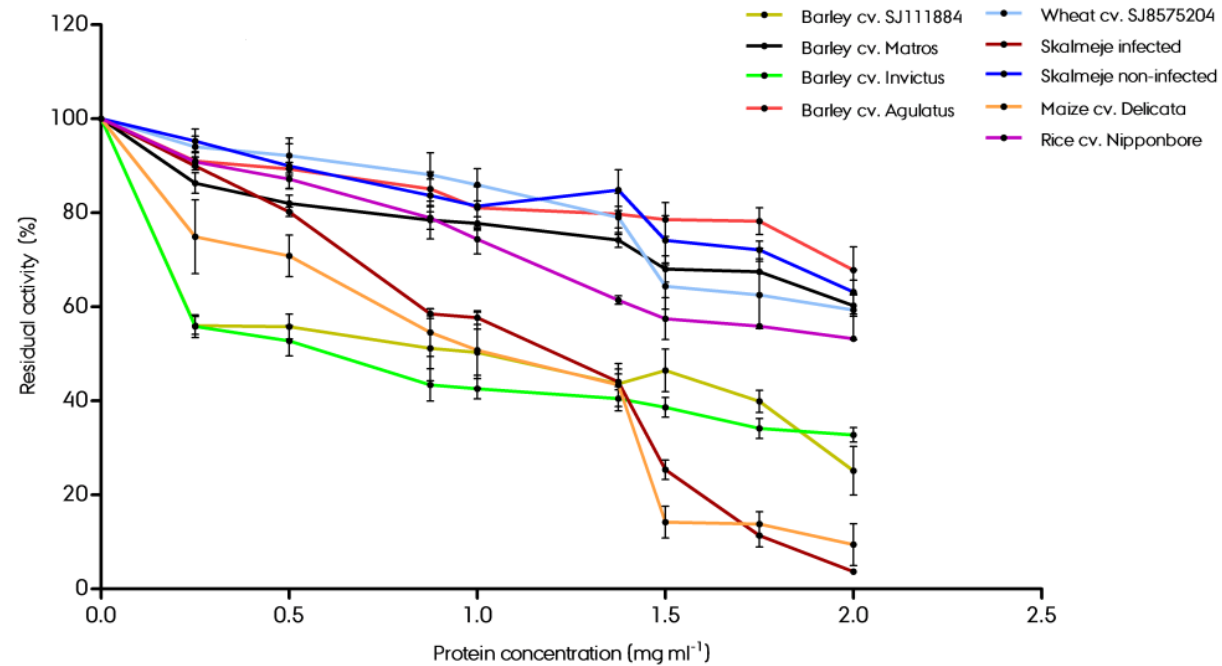


FUSARIUM ANVENDER FYTASE FOR AT FRIGØRE FOSFOR FRA PLANTENS FYTINSYRE



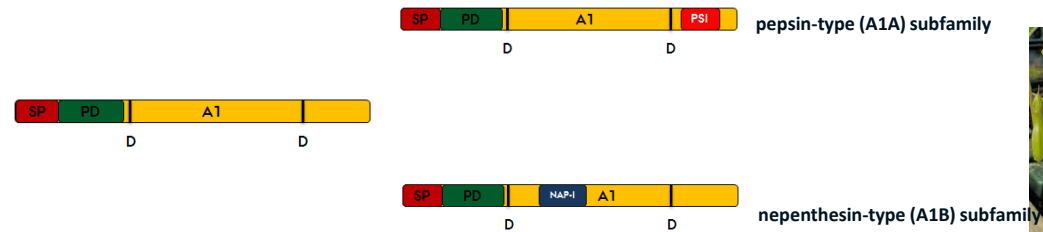
21

KORNKERNEN INDENHOLDER EN ELLER FLERE HÆMMERE AF FYTASE FRA FUSARIUM



HÆMMEREN AF FUSARIUM FYTASE ER PROTEINET NEPENTHESIN (NEP1)

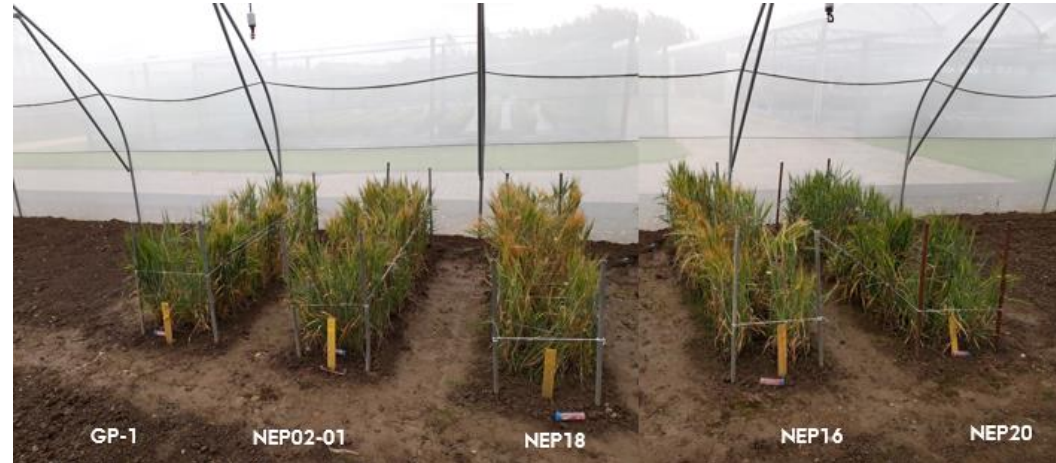
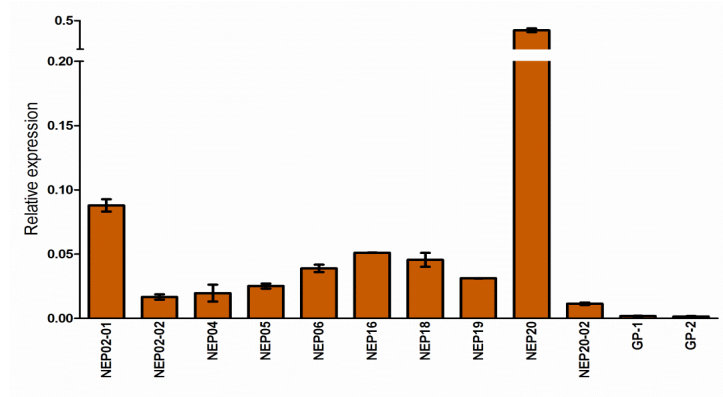
Nepenthesin-type aspartic protease (HvNEP-1) came up as top candidate



Nepenthes (Pitcher) plants

- Nep1 angriber som protease patogenprotein mange steder.
- Nep1 giver en grundbeskyttelse imod en række plantepatogener.

HØJT UDTRYK AF KORNKERNENS NEPENTHESIN GIVER FUSARIUM RESISTENS



ØGET FUSARIUM RESISTENS MED NYE PLANTEFORÆDLINGSTEKNIKKER



AARHUS
UNIVERSITET
INSTITUT FOR AGROØKOLOGI

5. JANUAR 2025

HENRIK BRINCH-PEDERSEN
PROFESSOR, HEAD OF SECTION



DE NYE TEKNIKKER: “NYE PLANTEFORÆDLINGSTEKNIKKER” (NGT/PRÆCISIONSFORÆDLING) ?

Cis-, Intragenesis techniques.

Genome editing techniques:

ZFN: (Zinc-finger nuclease directed mutagenesis).

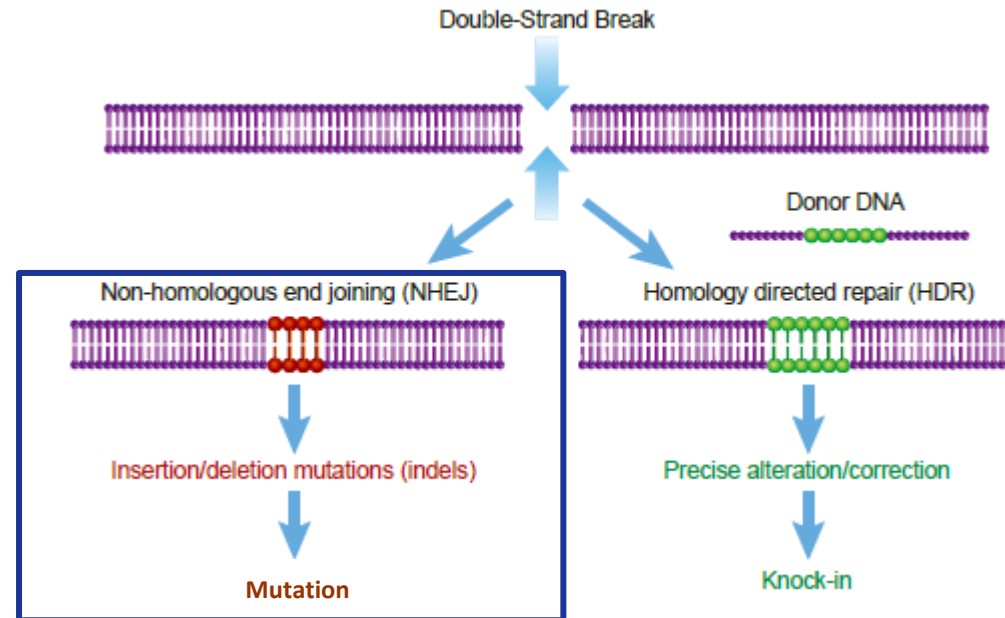
TALENs: (Transcription activator-like effector nucleases).

CRISPR/Cas (Clustred regulatory interspaced short palindromic repeats)/CRISPR- associated).

ODM: Oligonucleotide-directed mutagenesis.

Meganucleases.

MUTAGENESE MED NGT



- Reducerer antallet af sidemutationer.
- Reducere linkage drag.
- Øge forædlingshastigheden.

ØGET FUSARIUM RESISTENS MED NGT (HVNEP1 PROMOTER BASHING)

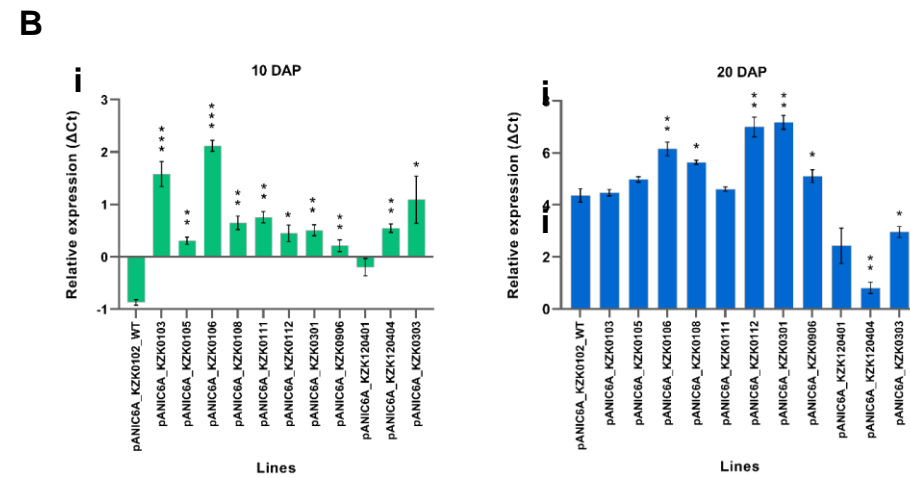
- Analyser nepenthesin genpromoterens for Cis-regulatory elements (CREs).
- Mutation af CREs med CRISPR/Cas og identification af mutationer, der påvirker nepenthesin ekspressionen.



Position and Functions of targets

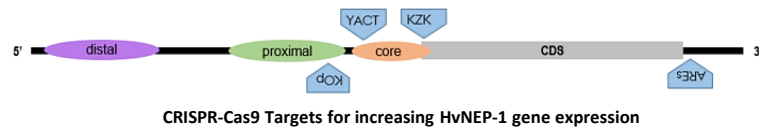
CREs	Target sequence	Function
KOp	TAAGCTGTTATAGTGACATC	Random promoter modification
YACT	CAGAGTGGTGGTAGATGTGC	Key component of Mem1 (mesophyll expression module 1), stress responses
KZK	ACATCAATGG	Transcriptional and Translational control
AREs	GTTTG	AREs influence mRNA stability, translation progress and alternative pre-mRNA processing

Mutation af byg HvNEP-1 Promoter og 3'UTR via NHEJ



Bekalu et al. In prep

Mutation af byg HvNEP-1 Promoter og 3'UTR med Base Editing

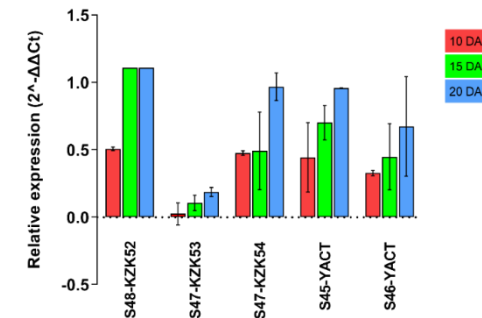


Position and Functions of targets

CREs	Target sequence	Function
KOp	TAAGCTGTTATAGTGACATC	Random promoter modification
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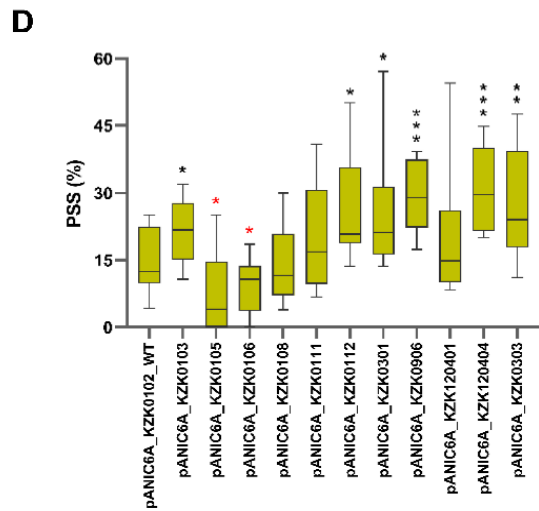
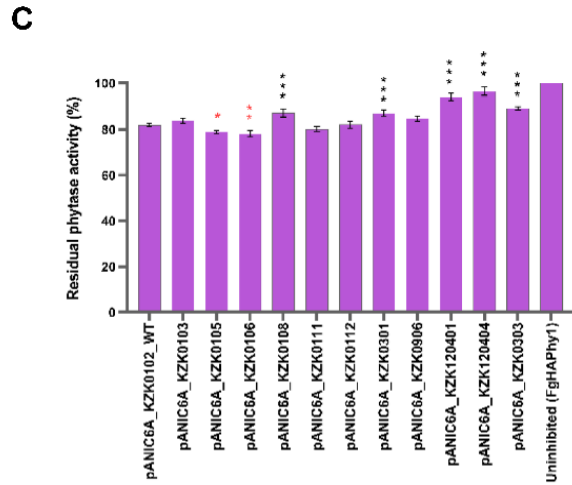
KZK mutated lines

YACT mutated lines



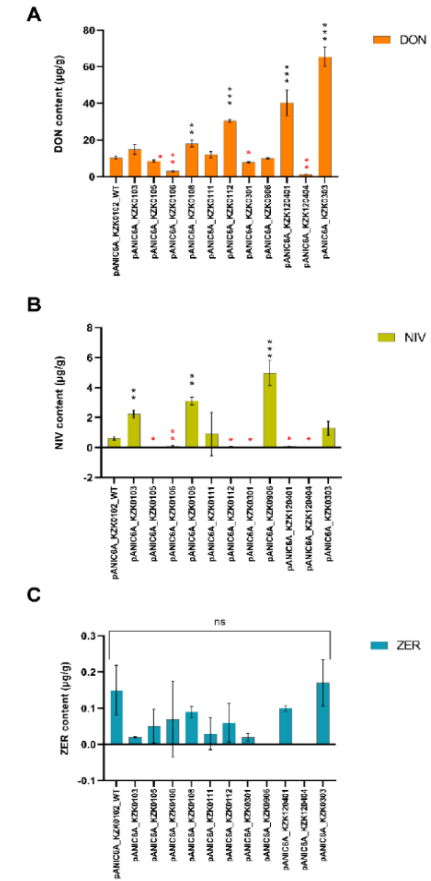
HvNEP-1 gene expression of the mutant lines

FUSARIUM AND NEP BARLEY (I)



Percentage of symptomatic spikelet's (PSS)

Myco toxin development



NYE VEJE TIL FUSARIUM RESISTENS

Proteinet nepenthesin kan give resistens imod Fusarium.

NEP-promotorerne kan muteres vha CRISPR/Cas teknologi.

Øget NEP-genekspression kan opnåes ved målrettet mutagenese.

Øget NEP-ekspression via NGT fører til forbedret Fusarium-resistens.

Øget NEP-ekspression via NGT reducerer niveauet af mykotoksiner.

People involved:

Zelalem Eshetu Bekalu

Michael Panting

Inger Holme

Henrik Brinch-Pedersen

ReTraQue

Innovationsfonden



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