



GMO RISK ANALYSIS SHORT COURSE

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science & innovation

Department:
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RISK ANALYSIS OF GMOs: Pathways to harm

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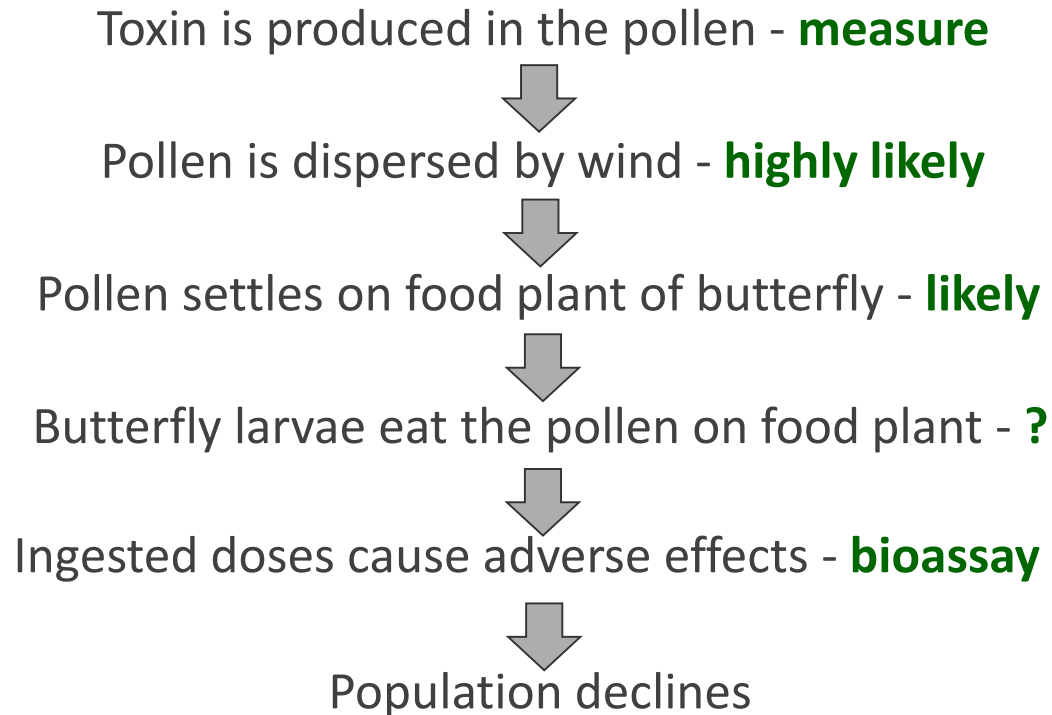
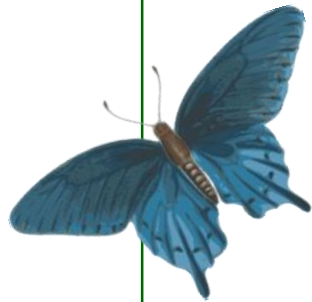
RISK ANALYSIS OF GMOs: Pathway to harm

- Define harm
- Postulate a pathway to harm
- What information would you need to falsify a pathway?
- Do you have information in order to characterise the likelihood and consequence
 - If not what additional data do you need?
- Can you characterise the risk?



Testing the Pathway to Harm

- ❖ Identify key steps in pathway, and add available data where pertinent
- ❖ Determine if the existing data break the pathway
- ❖ If not, identify what additional data would allow satisfactory testing of the hypothesis



Hypothesis Testing

In science, hypothesis can only be falsified, never proven

→ Formulate testable risk hypothesis

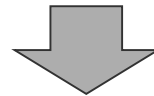
Scenario:

Ingested doses of toxic pollen cause adverse effects on the valued species



Risk hypothesis (H_0):

Ingested doses of toxic pollen cause no adverse effects on the valued species



Results:

No effects. Risk hypothesis corroborated ($\neq$ proven!)

Effect observed. Risk hypothesis rejected → harm is possible

Hypothesis Testing

H_0 : Ingested doses of toxic pollen cause no adverse effects on the valued butterfly species

Need to know:

- Toxin concentration in pollen
- Density of pollen grains on food plants
- Area of food plant leaves ingested
- Estimate realistic worst case exposure



Experimental testing:

- Neonates? (most susceptible)
- Test concentration? (10 x worst case dose → safety margin)
- Test duration? (1 week? Complete larval development?)
- Test system? (artificial diet + toxin or leaf pieces with pollen?)
- Endpoints? (mortality, developmental time, weight,...)

Pathway to Harm: Case Study

Risk hypothesis - Presence of ferritin protein in GM biofortified sorghum will cause allergic response in humans

- 1.
- 2.
- 3.
- 4.
- 5.
6. Incidences of allergenicity in Nigeria will result from consumption GM biofortified sorghum



Pathway to Harm: Case Study

Risk hypothesis - Presence of ferritin protein in GM biofortified sorghum will cause allergic response in humans

1. Biofortified sorghum contains ferritin
2. Ferritin is an allergen
3. Biofortified sorghum enters human food chain
4. Biofortified sorghum processed for food
5. Consumption of biofortified sorghum meals
6. Incidences of allergenicity in Nigeria will result from consumption GM biofortified sorghum



Pathway to Harm – 2: Risk Evaluation

Risk hypothesis - Presence of ferritin protein in GM biofortified sorghum will cause allergic response in humans

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1. Biofortified sorghum contains ferritin – **Highly Likely**
 2. Ferritin is an allergen ← **CRITICAL STEP*** – **Highly Unlikely**
 3. Biofortified sorghum enters human food chain – **Highly Likely**
 4. Biofortified sorghum processed for food – **Highly Likely**
 5. Consumption of biofortified sorghum meals – **Highly Likely**
 6. Incidences of allergenicity in Nigeria will result from consumption GM biofortified sorghum - **Highly Unlikely & Minor** - **OVERALL NEGLIGIBLE RISK**



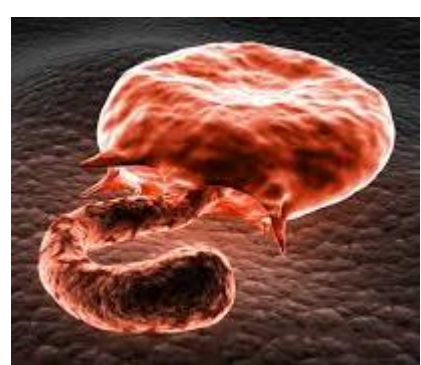
Data shows ferritin has no sequence similarity with known allergens and is susceptible to *in vitro* pepsin digestion & simulated gastric fluid digestion

Pathway to Harm – 3: Case Study

Risk hypothesis - Consumption of GM biofortified sorghum will increase iron in the body which will increase high malaria prevalence



1. Humans consume GM biofortified sorghum
2. Fe from GM biofortified sorghum will be bioavailable in the human body
3. The sorghum-derived bioavailable Fe will add to current levels and result in an overall increase of Fe concentration in human blood
4. Increased Fe concentration will be preferentially uptaken by malarial parasites present in the blood
5. The additional uptake of Fe will lead to an increase in the multiplication of malarial parasites present in the blood
6. More malarial parasites in the blood will lead to greater incidences or more severe incidences of malaria



Pathway to Harm – 3: Risk Evaluation

Risk hypothesis - Consumption of GM biofortified sorghum will increase iron in the body which will increase high malaria prevalence

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1. Humans consume GM biofortified sorghum – **Highly Likely**
 2. Fe from GM biofortified sorghum will be bioavailable in the human body – **Highly Likely**
 3. The sorghum-derived bioavailable Fe will add to current levels and result in an overall increase of Fe concentration in human blood – **Likely**
 4. Increased Fe concentration will be preferentially uptaken by malarial parasites present in the blood ← **CRITICAL STEP*** – **Likely**
 5. The additional uptake of Fe will lead to an increase in the multiplication of malarial parasites present in the blood – **Highly Likely**
 6. More malarial parasites in the blood will lead to greater incidences or more severe incidences of malaria – **Likely & Intermediate - OVERALL MODERATE RISK**
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*WHO Recommendations are that, where the prevalence of malaria and other infectious diseases is high, iron and folic acid supplementation be targeted only to those who are anaemic and at risk of iron deficiency

GM Biofortified Sorghum Summary

Risk Hypothesis 1 - Incidences of allergenicity in Nigeria will result from consumption GM biofortified sorghum - **OVERALL NEGLIGIBLE RISK**

Risk Hypothesis 2 - Consumption of GM biofortified sorghum will increase iron in the body which will increase high malaria prevalence - **OVERALL MODERATE RISK**



Level of risk	Risk evaluation definitions
Negligible	Risk is of no discernible concern and there is no present need to invoke actions for mitigation
Low	Risk is of minimal concern, but may invoke actions for mitigation beyond standard practices
Moderate	Risk is marked concern and will necessitate actions for mitigation that need to be demonstrated as effective
High	Risk is of considerable concern that is unacceptable unless actions for mitigation are highly feasible and effective





THANK YOU

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