Development of lactulose technology and reagentless methods

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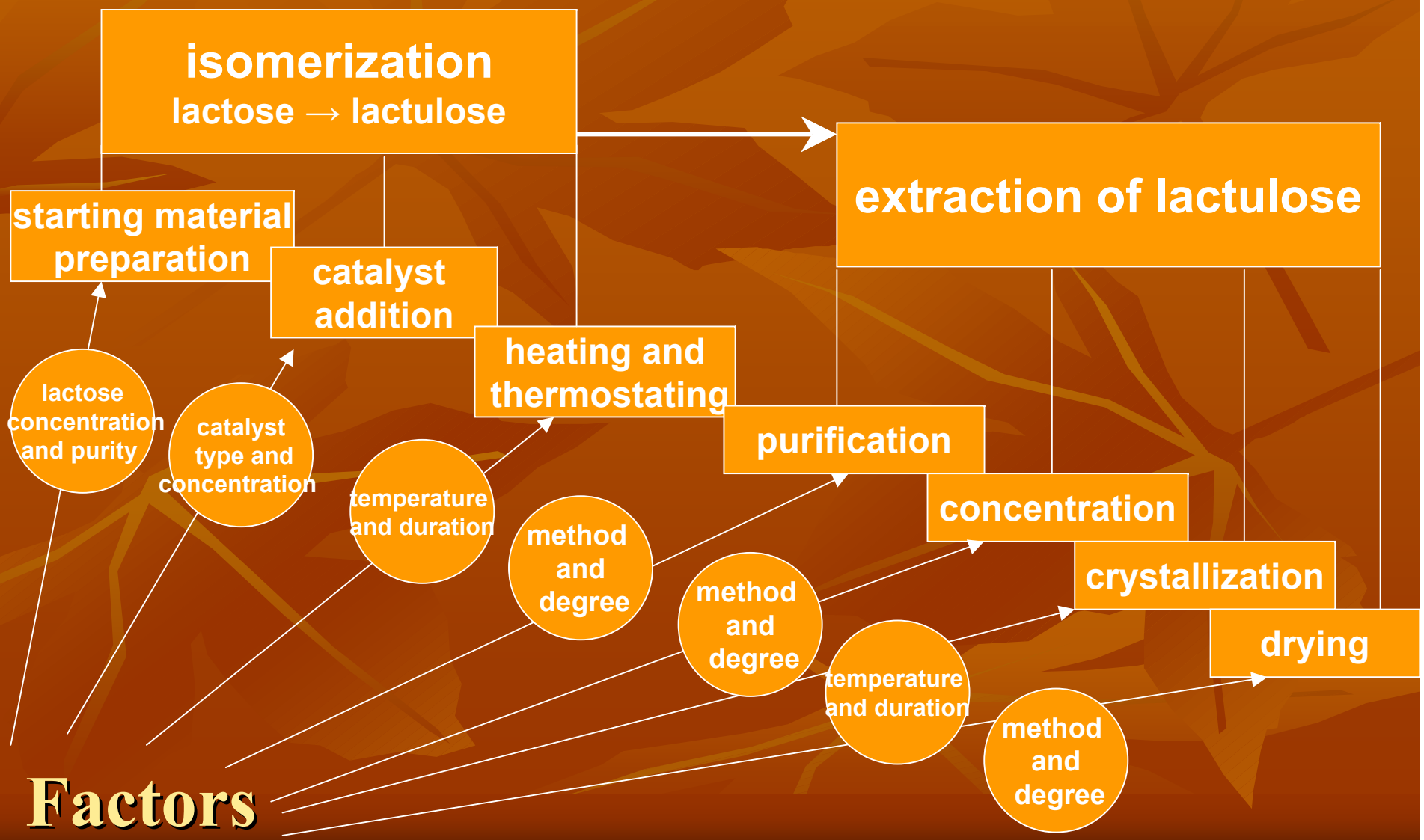
- **Lactulose technology - structure, directions and stages of development**
- **Application of alkaline reagents**
- **Application of complexing reagents**
- **Application of reagentless methods**
- **Electroactivation as reagentless method**
- **Dynamics of patenting**

Lactulose technology



Alkaline reagents application

1930
Montgomery&Hudson

- $Ca(OH)_2$
  - $t \uparrow, \tau \downarrow$
  - CaO
    - from whey
    - from whey permeate
- NaOH
  - demineralisation methods
  - non-reacted lactose removal
  - decolorizing
    - $+ H_2O_2$
    - +chlorite
    - $\downarrow pH$
- KOH
- sulfite
- bisulfite
- phosphite
- carbonate

Complexing reagents application

Aluminate

$Na\,[Al(OH)_4]$

Borate

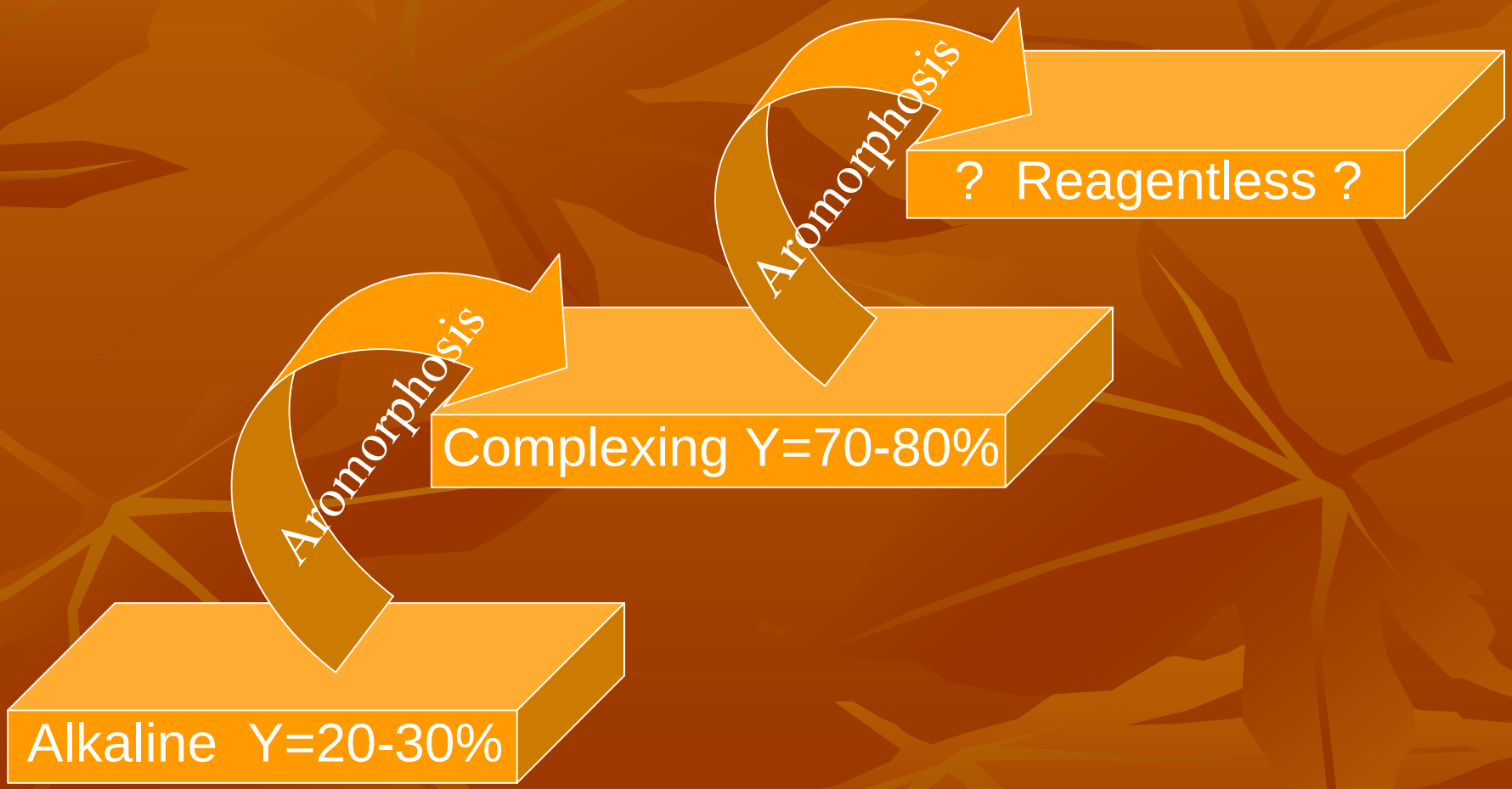
$Na_2\,B_4\,O_7$

$H_3\,BO_3 + NaOH$

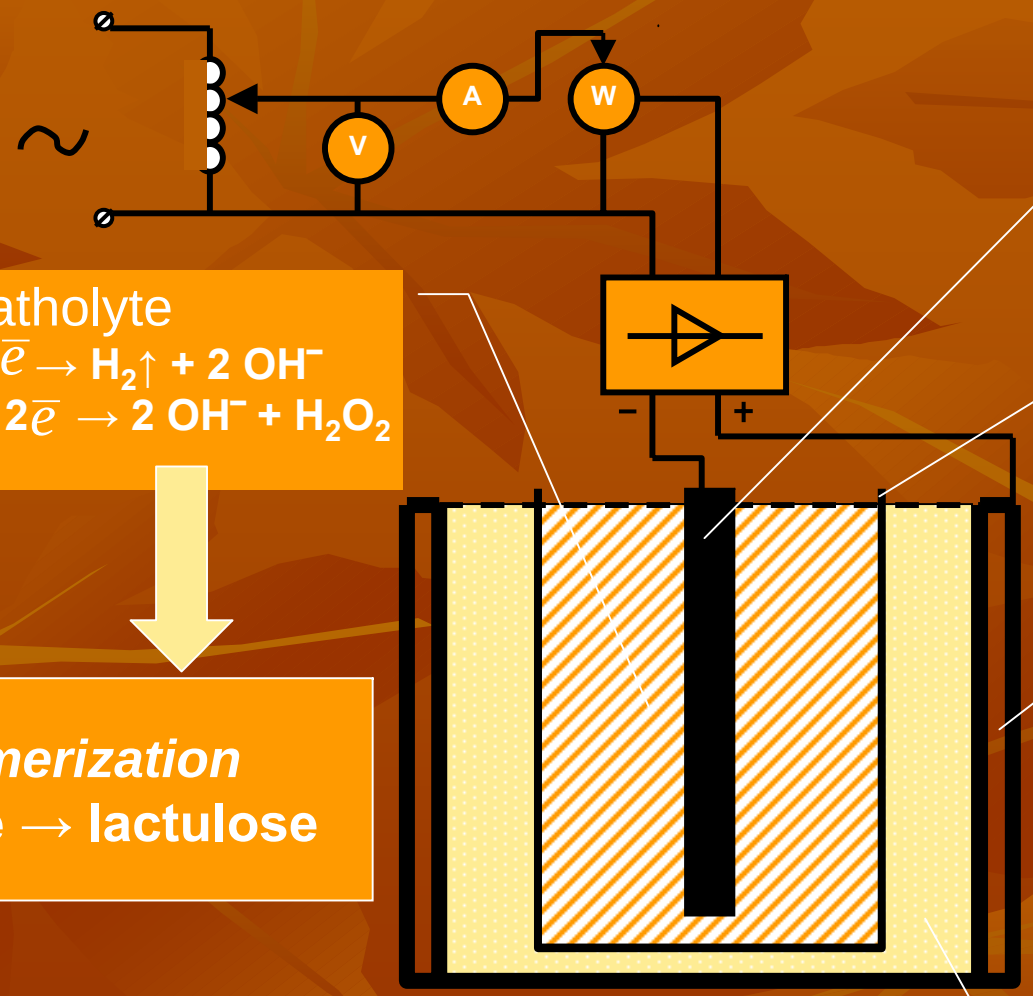
- precipitation
- centrifugation
- membranous technique
  - ultraosmosis
  - electrodialysis
  - diafiltration
- ion exchange
  - strong acid
  - adsorption
  - boron selective

purification methods

Lactulose technology evolution



Principles of electroactivation



cathode

membrane

anode

catholyte

$2\ H_2O + 2\bar{e} \rightarrow H_2\uparrow + 2\ OH^-$

$O_2 + 2\ H_2O + 2\bar{e} \rightarrow 2\ OH^- + H_2O_2$

isomerization

lactose → lactulose

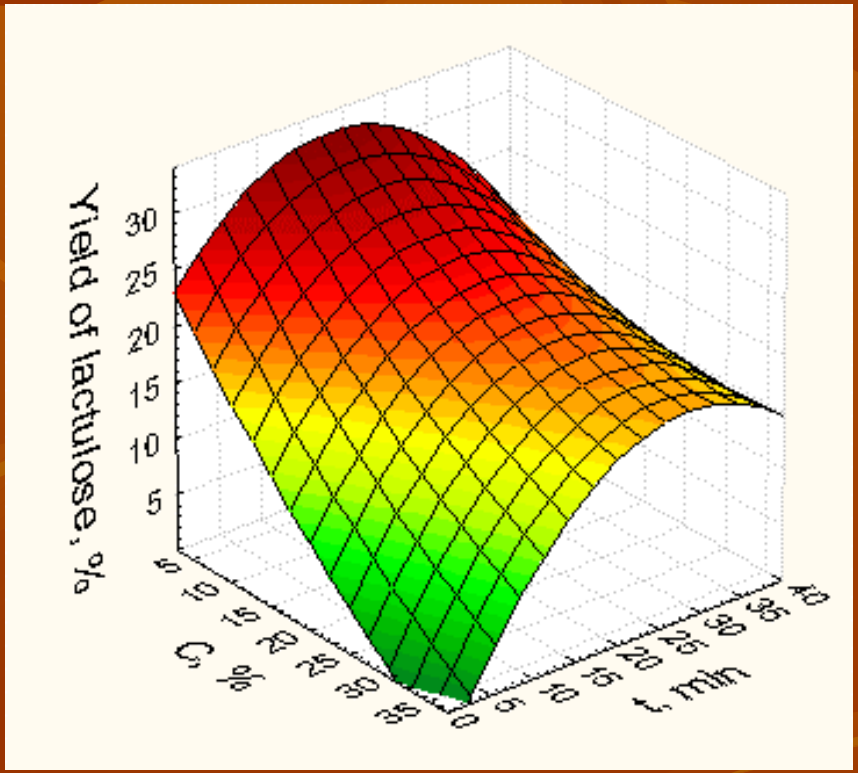
anolyte

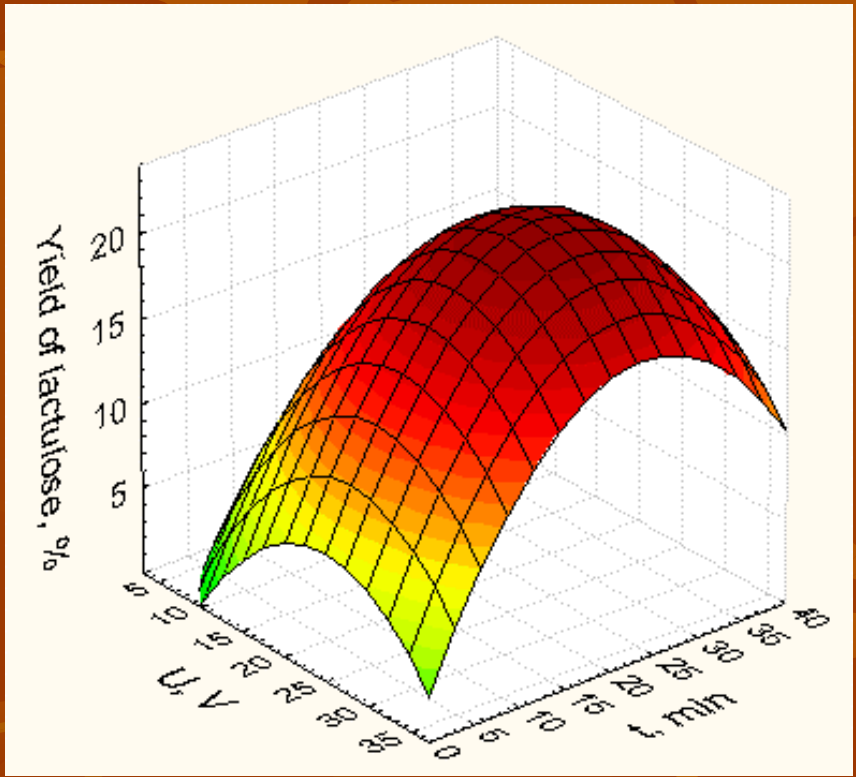
$2\ H_2O - 4\ \bar{e} \rightarrow O_2\uparrow + 4H^+$

Lactulose formation via electroactivation of lactose solution

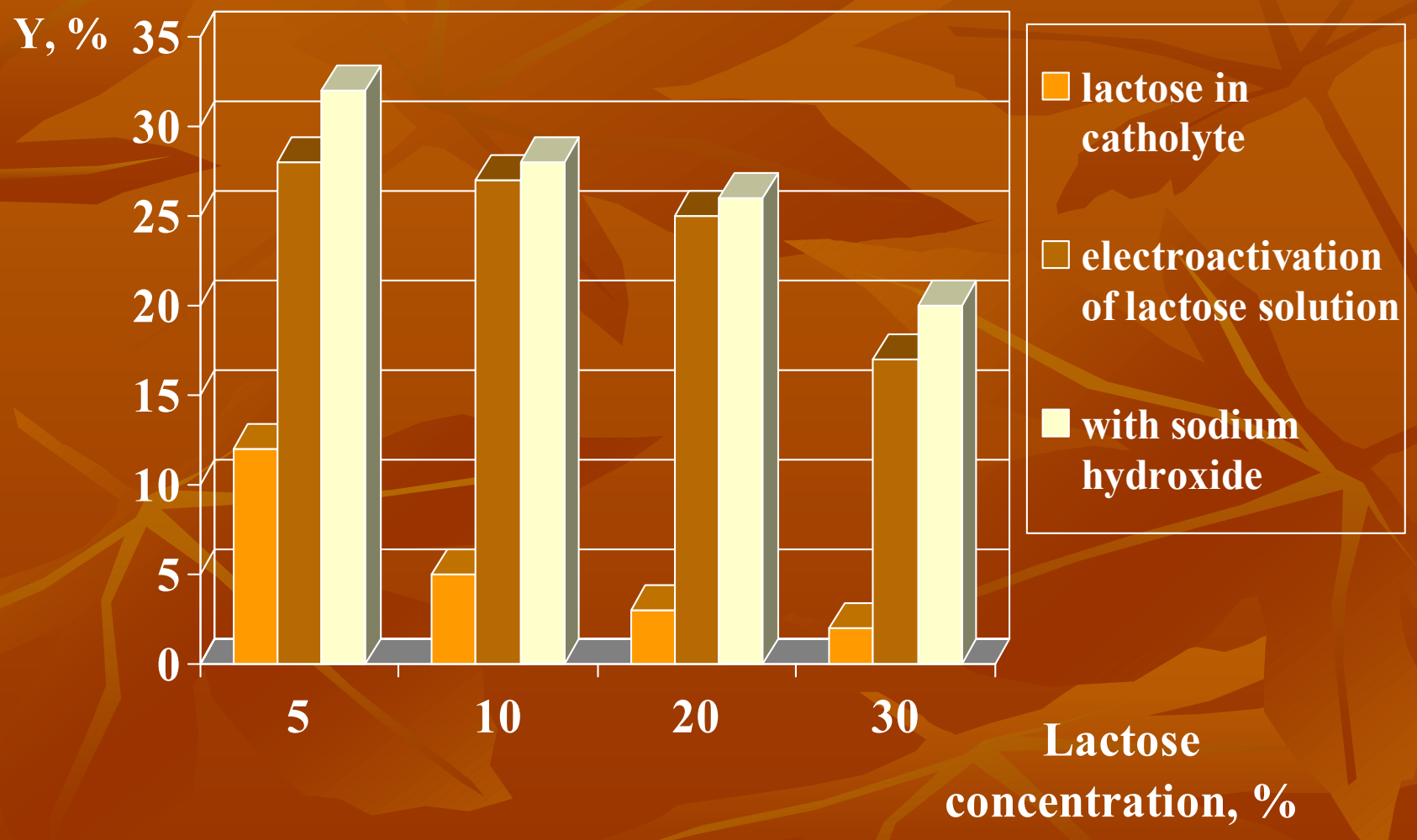
Dependence of lactulose yield on lactose concentration (C), voltage (U) and duration (t) of solution electroactivation

$$Y = 5{,}460 - 1{,}065C + 1{,}645U + 0{,}948t + 0{,}007C^2 - 0{,}033U^2 - 0{,}027t^2 + 0{,}016Ct$$





Lactulose yield at different processing conditions



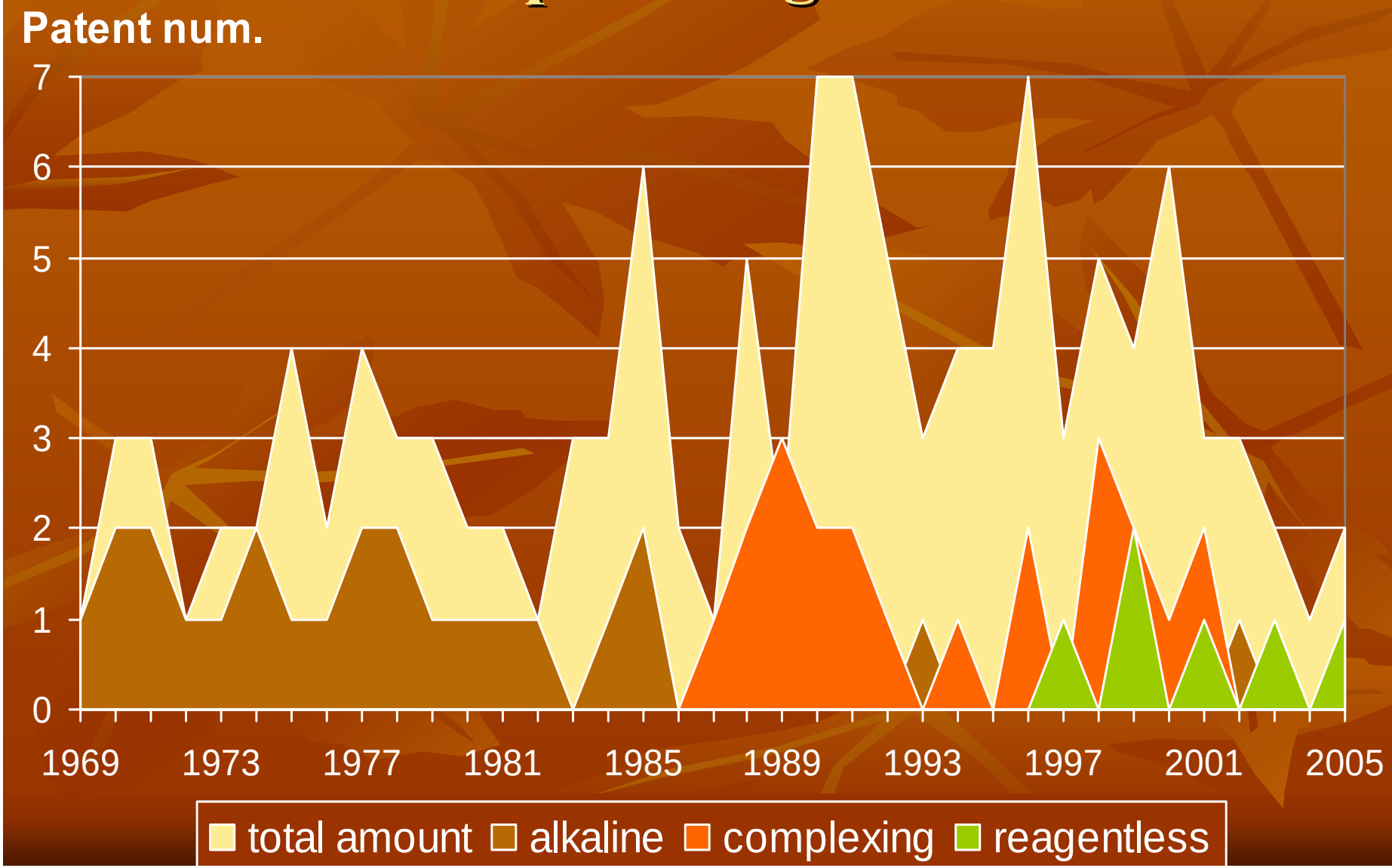
You can get more information about our researches in posters:

- Reagentless lactulose technology
- Application of food additives with lactulose in fermented products technology
- Microflora of whey and whey products
- Prebiotic concentrates with lactulose on the basis of dairy protein-carbohydrate raw material

and monographs:

- Lactulose technology (by Rjabtseva S.A)
- Lactose and its derivatives (by Sinelnicov B.M., Hramtsov A.G., Evdokimov I.A., Rjabtseva S.A., Serov A.V.)

Lactulose production methods patenting



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