# Metabolismo Energético

2018/19
T10

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Anabela Bernardes da Silva

## Sacarose e amido: produção a nível mundial

Sacarose

**Cana do açúcar (planta C4)**

Rendimento até 10% sacarose / 90 % da planta

Máximo 10 ton plantas / hectare

**Beterraba sacarina (planta C3)**

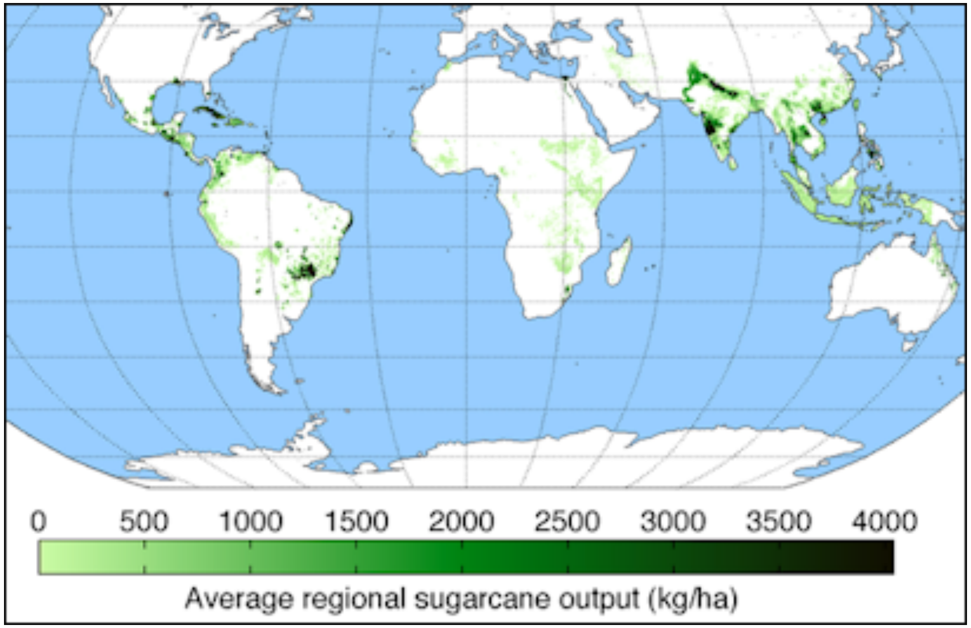
Rendimento até 17% sacarose/ 83 % da planta

Máximo 7 ton plantas / hectare

- **120 países têm uma produção significativa de sacarose,**
- **170 milhões de toneladas/ ano aprox.**
- **India, Australia, Brazil, Estados Unidos da América, são os principais produtores**

http://factsanddetails.com/world/cat54/sub345/item1569.html

## Produção de cana-do-açúcar a nível mundial e produção de bioetanol




Cana do açúcar (planta C4)

- Bioetanol produz energia e tem baixas emissões de $CO_2$
- Bioetanol produzido a partir de açúcar < menos dispendioso do que o obtido a partir de amido
- Bioetanol produzido a partir de açúcar produz energia > ao obtido a partir de amido
- beterraba > cana-do-açúcar > cassava > sorgo > milho

http://factsanddetails.com/world/cat54/sub345/item1569.html

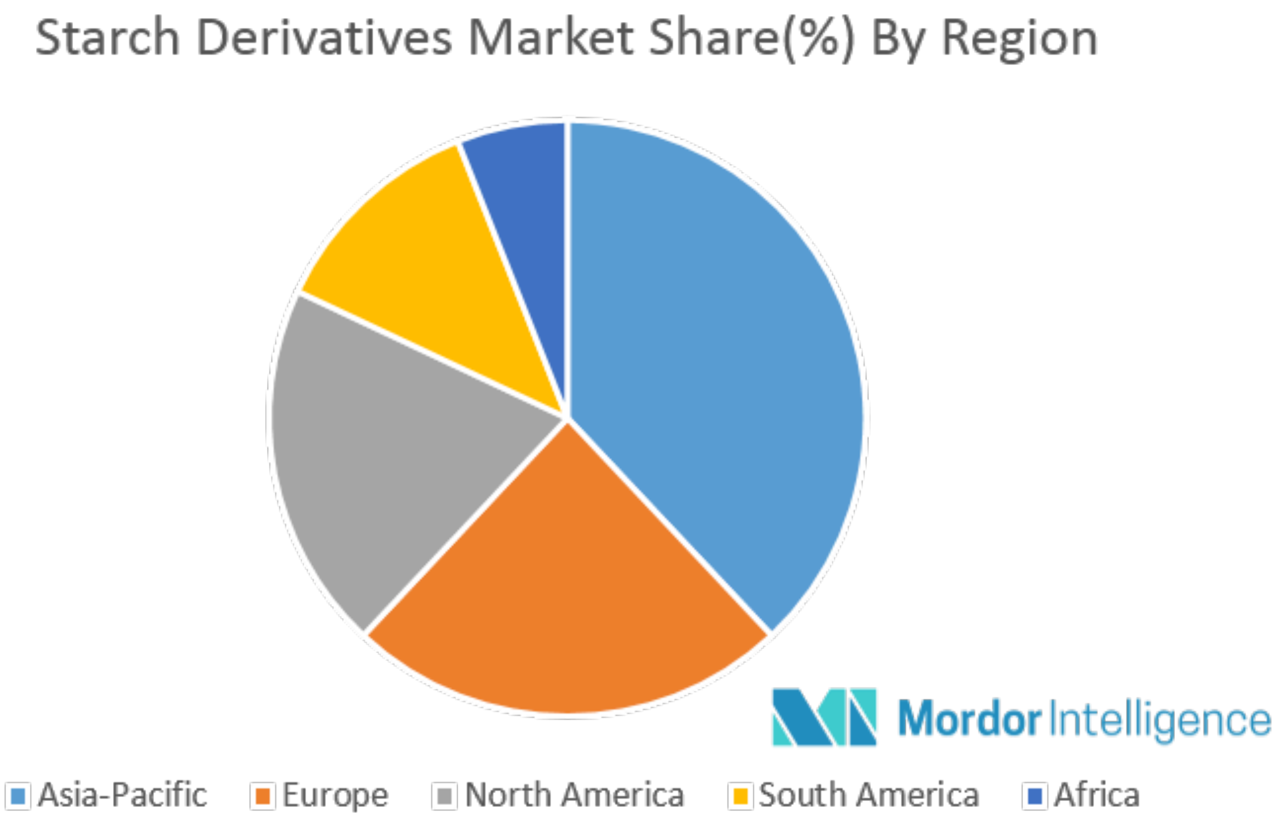
## Produção de bioetanol

*"The Global Bioethanol Market is Projected to Reach USD 68.95 Billion By 2022. "*

Mercado global de bioetanol deverá :

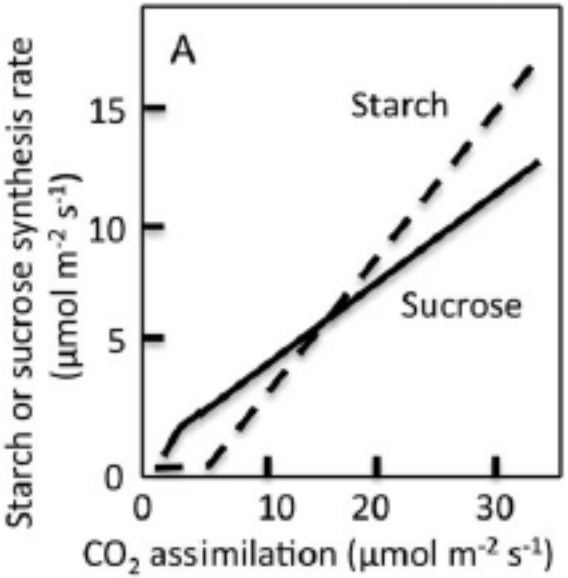
- aumentar 5,3% de 2016 a 2022
- manter-se baseado no amido
- Aumentar a produção baseada na celulose

https://www.researchandmarkets.com/research/57z2m8/bioethanol_market


Starch Derivatives Market Share(%) By Region
Mordor Intelligence
Asia-Pacific
Europe
North America
South America
Africa

# The role of transitory starch in $C_3$, CAM, and $C_4$ metabolism and opportunities for engineering leaf starch accumulation

- O que é o amido transitório?
- Quando se forma?
- Será diferente nas plantas C3, C4 e CAM?




*Journal of Experimental Botany*, Vol. 62, No. 9, pp. 3109–3118, 2011

**The role of transitory starch in $C_3$, CAM, and $C_4$ metabolism and opportunities for engineering leaf starch accumulation**

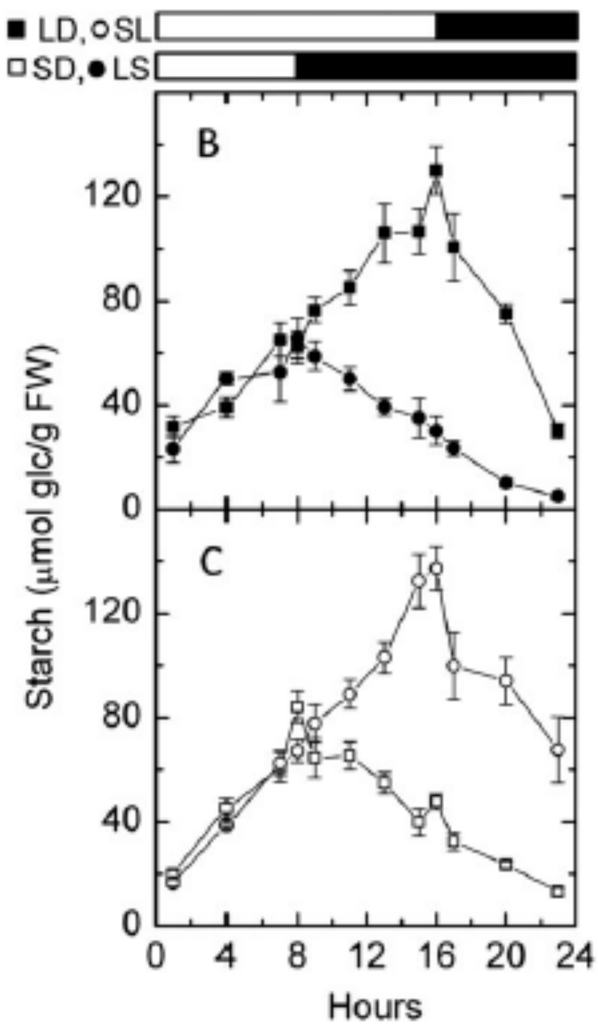



**Fig. 1.** Effects of photosynthetic rate (A) and day length (B, C) on starch synthesis rates. Photosynthesis was varied by changing either light or $CO_2$, and the amount of radioactivity fed to leaves that went into the non-ionic soluble (sucrose) or insoluble (starch) fractions was determined [redrawn from Sharkey *et al.*, 1985 (Copyright American Society of Plant Biologists, www.plantphysiol.org)]. Starch accumulated linearly in *Arabidopsis* plants grown in 16 h (b) or 8 h (c) days (square symbols). Plants shifted from long to short or short to long day (circles) adapted to the new night length on the first night. Data reprinted from Lu *et al.* (2005) (Copyright American Society of Plant Biologists, www.plantphysiol.org).

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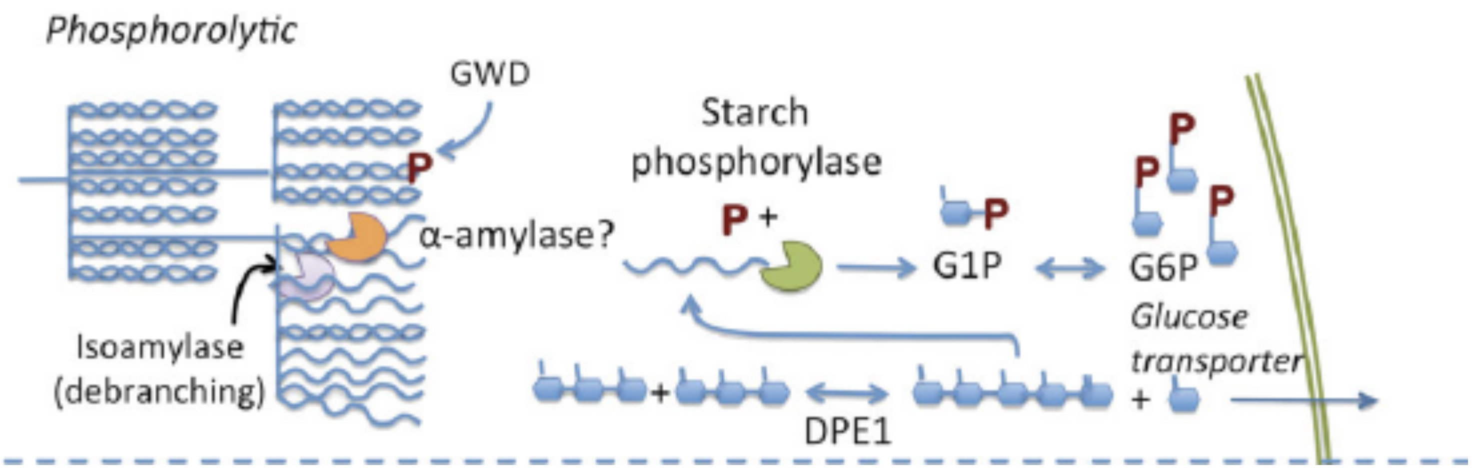



**Fig. 2.** Phosphorolytic (top) and hydrolytic (bottom) pathways of starch breakdown. It is assumed that the glucan water dikinase (GWD) is required for both pathways, but the involvement of phosphoglucan water dikinase (PWD) and glucan phosphatase (SEX4) in phosphorolytic starch degradation has no experimental support yet. The involvement of α-amylase in phosphorolytic starch breakdown is speculation. Both pathways produce some glucose that is exported, but with no GPT expressed in green tissue the G6P produced stays inside the chloroplast. It is speculated in this figure that β-amylase attacks both the phosphorylated starch granule and maltodextrins released from the starch granule. Exported maltose is metabolized by disproportionating enzyme 2 (DPE2) releasing one glucose and transferring the other to an arabinogalactan. The glucose on the arabinogalactan is cleaved phosphorolytically to make G1P, while the free glucose is phosphorylated to G6P by hexokinase (HXK). Each hexagon represents one glucose residue (with carbon six shown as a line).

# The role of transitory starch in $C_3$, CAM, and $C_4$ metabolism and opportunities for engineering leaf starch accumulation

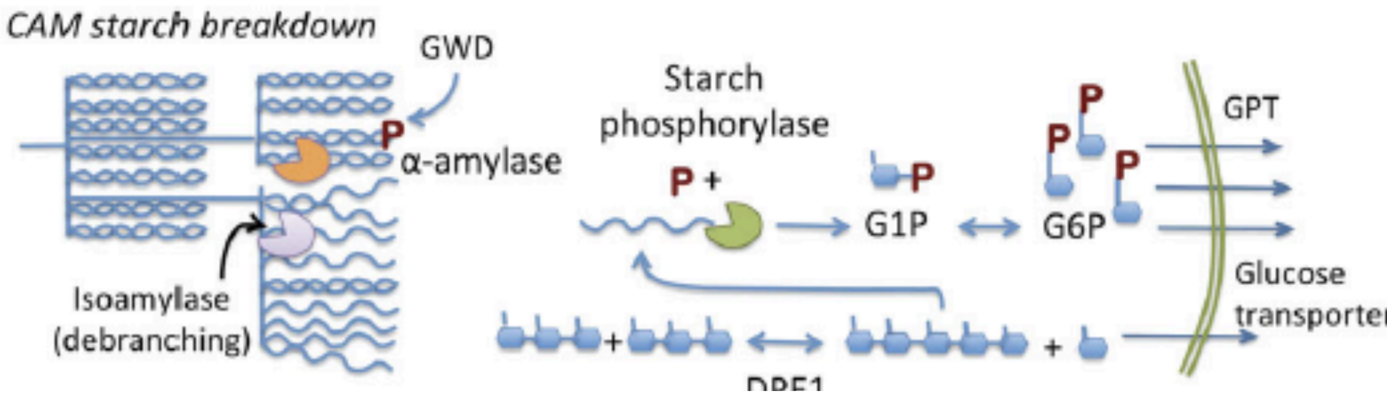
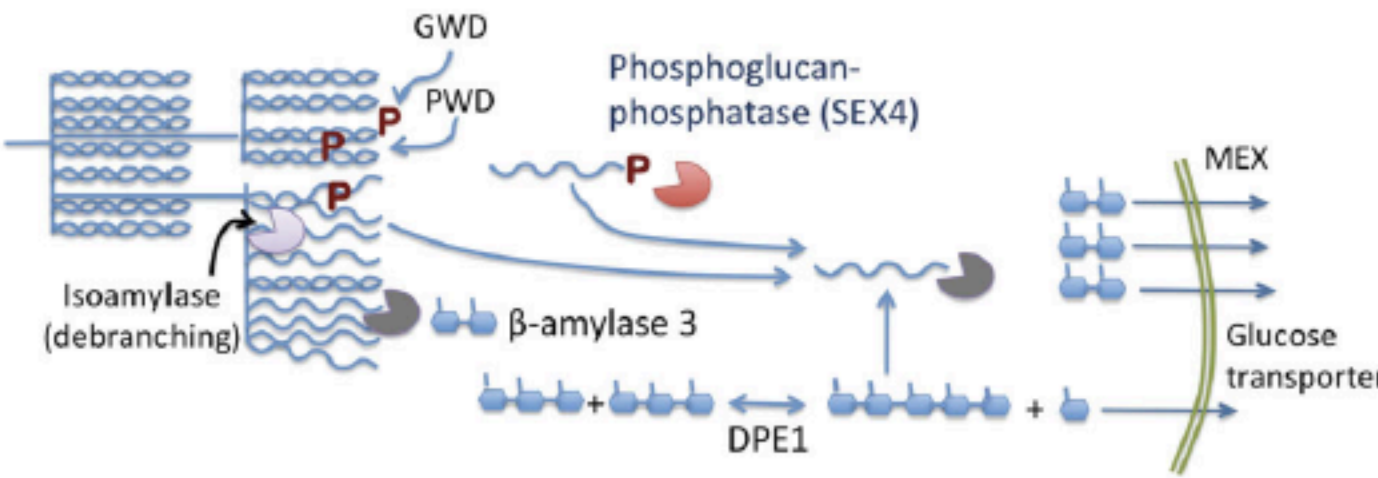



**Fig. 4.** Presumed pathway of starch breakdown and carbon export from chloroplasts for plants in CAM mode (top) or $C_3$ (mode) (bottom). Based on ideas in Fig. 2 and data in Fig. 3 MEX is the maltose exporter.

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# The role of transitory starch in $C_3$, CAM, and $C_4$ metabolism and opportunities for engineering leaf starch accumulation

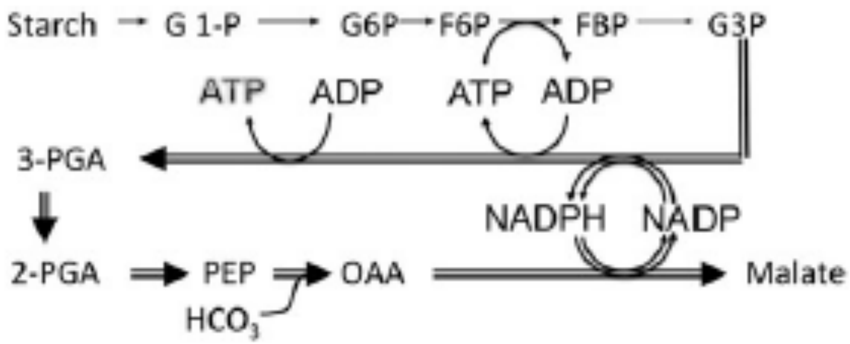


**Fig. 5.** Conversion of starch to phospho*enol*pyruvate (PEP) at night and subsequent metabolism to malate. This pathway results in a net gain of one ATP at night. G6P export allows all ATP and NADPH generation and consumption to occur in the cytosol. If triose phosphates were exported, ATP would be required inside the chloroplast but generated outside the chloroplast.

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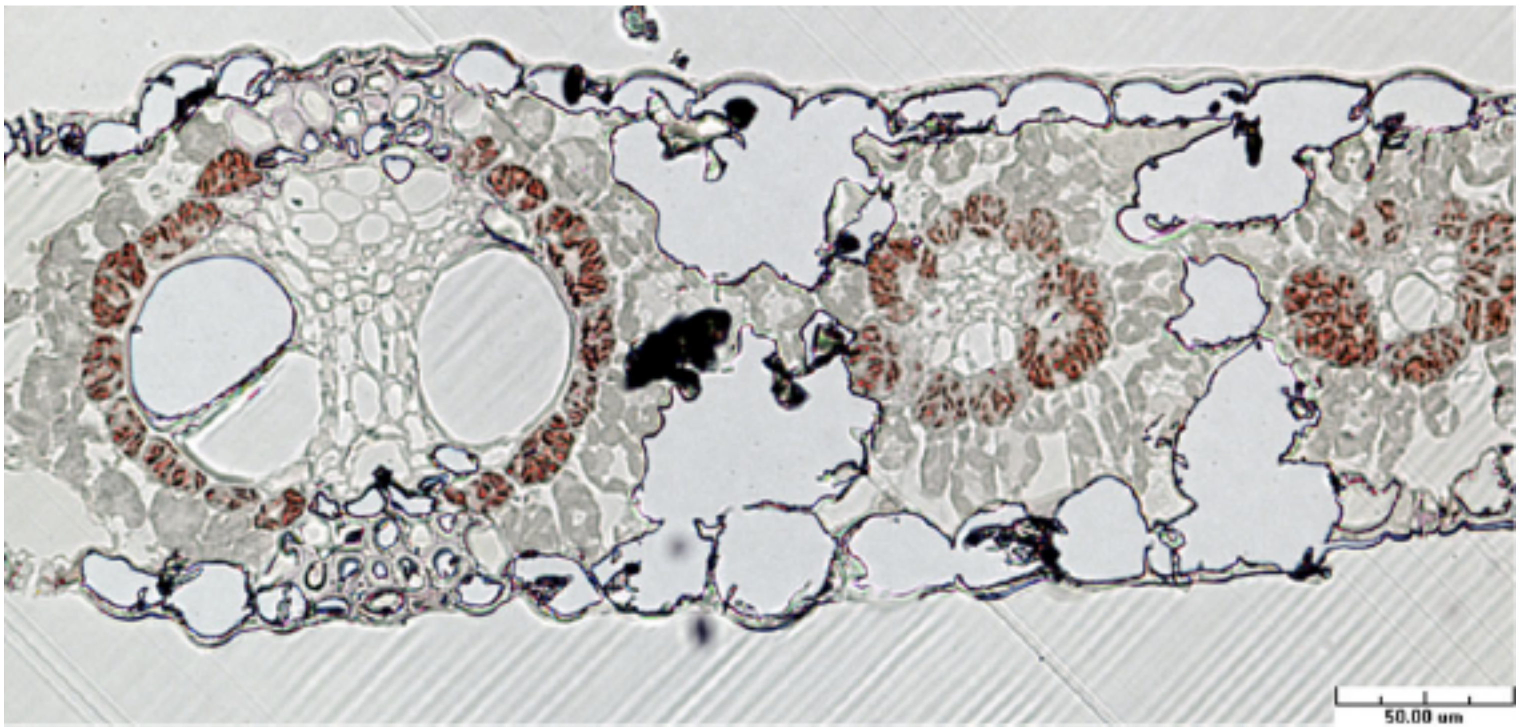


**Fig. 6.** Section of a leaf of *Zea mays* stained with IKI showing starch accumulation in bundle sheath cells only in this plant in which RNAi reduced GWD. The leaf was taken for fixation at 11:00 AM (SEW and TDS, unpublished).

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