Carotenoid retention and vitamin A activity in dried orange-fleshed sweet potato that is cooked, fried or stored

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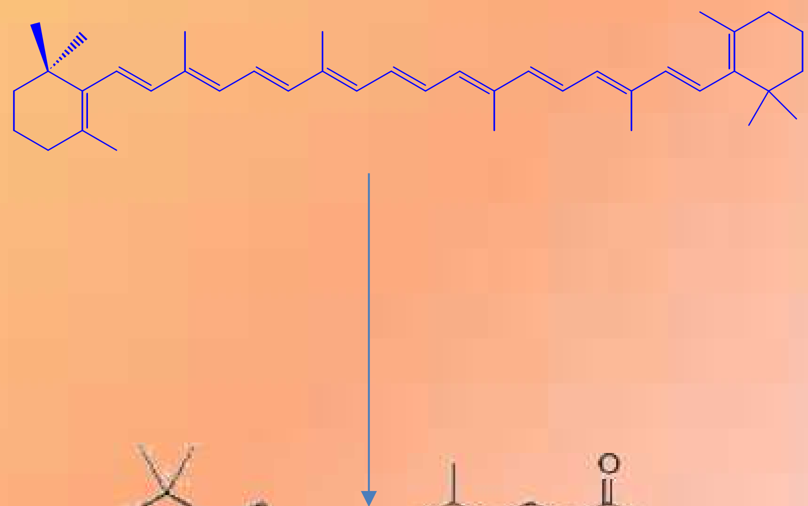
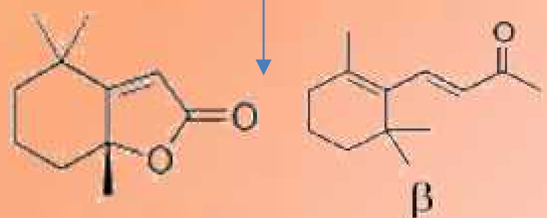
Background

- Provitamin A carotenoids (pVACs) important for health
- Visible trait (yellow or orange)





- pVACs can be degraded during cooking or processing

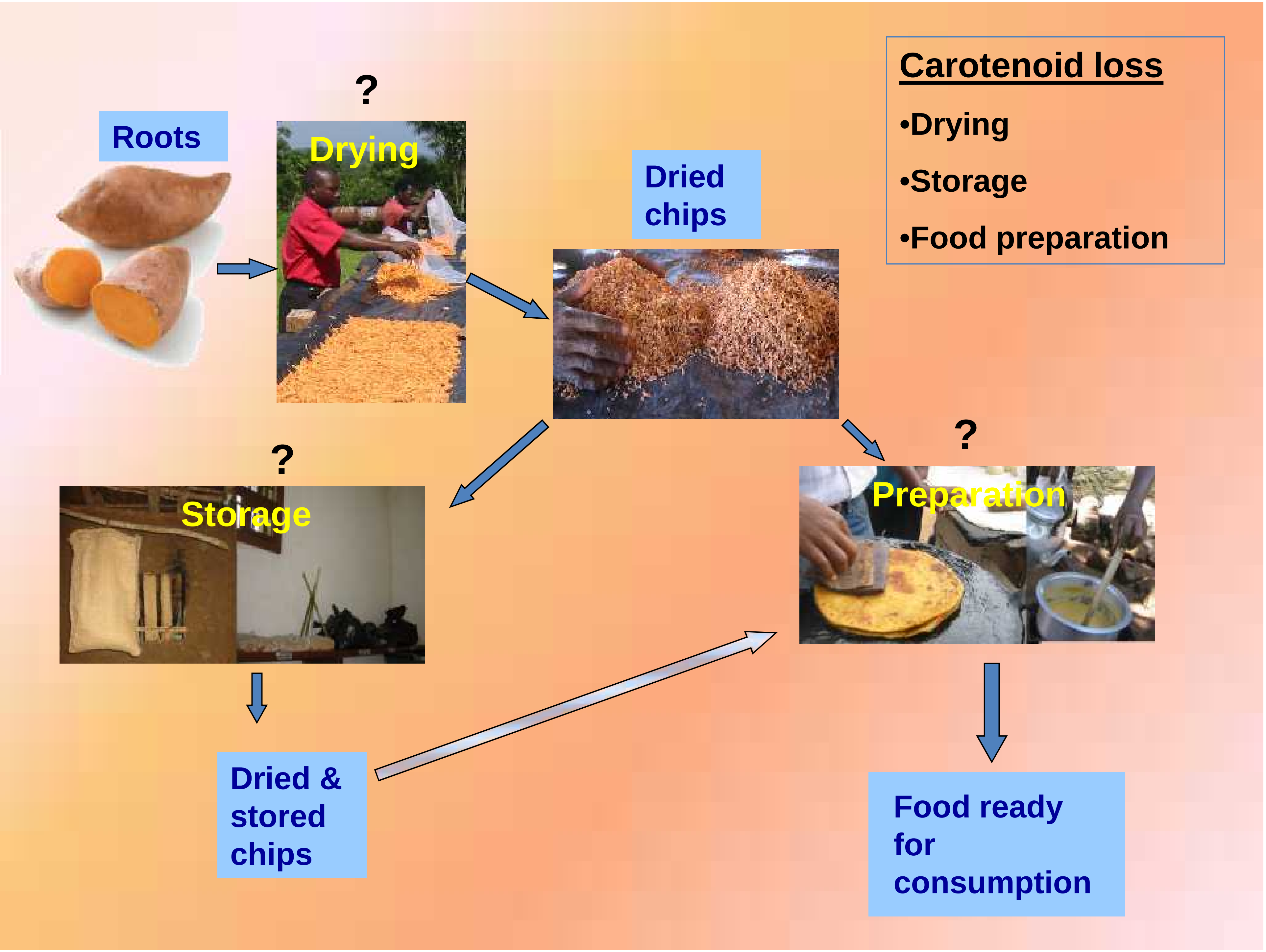
Issues

- Provit. A retention
  - after storage of dried OFSP?
  - after food preparation using dried OFSP (flour)?

- Little information in the literature (i.e. regarding the developing countries situation)

Background

- Main preparation of SP in Africa: boiling, steaming & drying
- Drying: facilitate transport & storage during off-season.
- Variety of products can be made from dried sweet potato


Carotenoid loss
•Drying
•Storage
•Food preparation
Roots
?
Drying
Dried chips
?
Storage
?
Preparation
Dried & stored chips
Food ready for consumption

- Two studies; 1 storage; 1 food preparation - Journal publications:
- ***Journal of Agricultural & Food Chemistry*** (2011)
- ***Food Chemistry*** (2010)
- part of PhD thesis (2006-2010)

http://sweetpotatoknowledge.org/use-consumption/nutritional-information/processing-and-nutrition-retension/Aurelie%20Bechoff%20PhD%20thesis-final.pdf/view

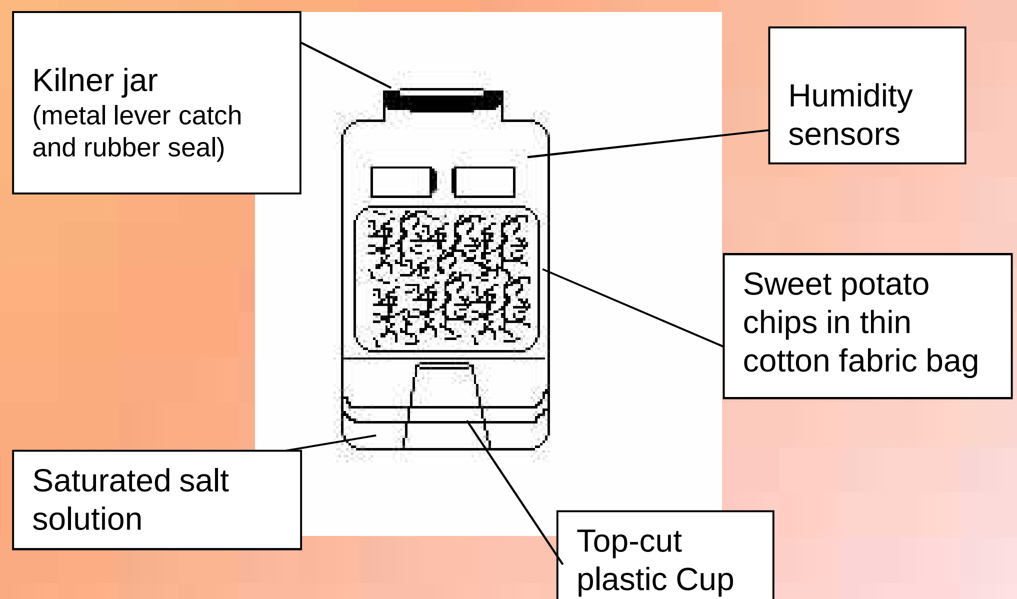
Storage study

Bechoff, A., Dhuique-Mayer, C., Dornier, M., Tomlins, K., Boulanger, R., Dufour, D. & Westby, A. (2010). Relationship between the kinetics of β-carotene degradation and norisoprenoid formation in the storage of dried sweet potato chips. ***Food Chemistry***, 121, 348–357.

Storage under controlled conditions

Ugandan dried chips (Ejumula variety)

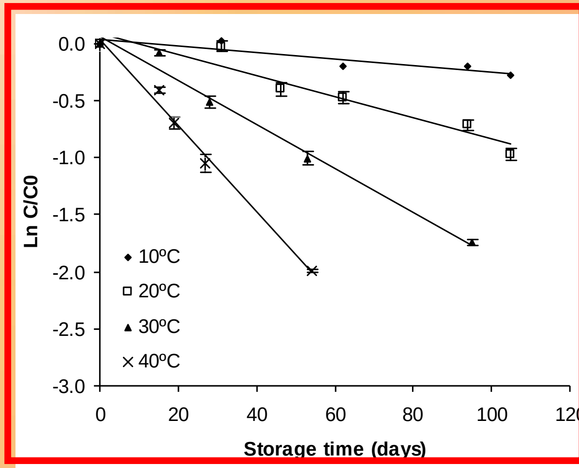
- 4 temperatures (10; 20; 30; 40°C)
- 4 aw (0.1; 0.3; 0.5; 0.7)
- 4 oxygen levels:0% (N_2), 2,5 % et 10% O_2, 21% (air)



Carotenoid degradation during storage was influenced by temperature (T): Arrhenius model

$$\ln \frac{C}{C_0} = -kt$$

1st order kinetic



$$k = k_{\infty} e^{-\frac{Ea}{RT}}$$

Arrhenius equation

k=constant degradation (day^{-1})

Ea = Activation energy (kJ.mol^{-1})

R =universal molar gas constant

Experimental data validated model

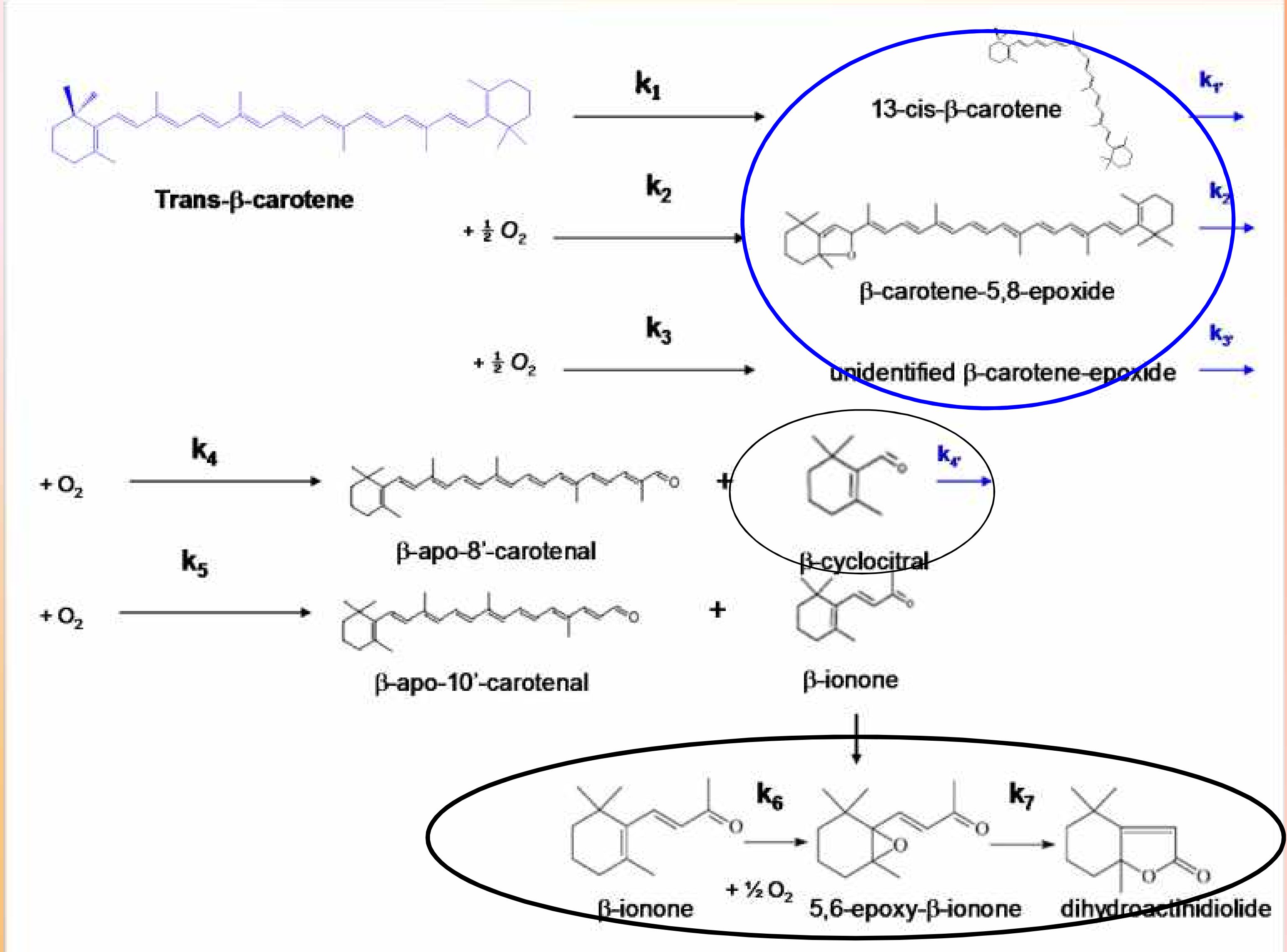
4.3 % difference

88 days at ambient temperature (recorded) in laboratory

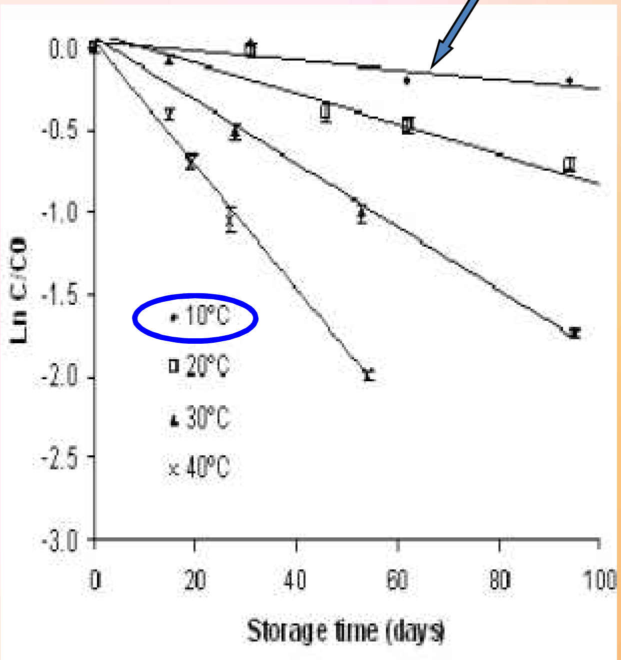
9.3 % difference

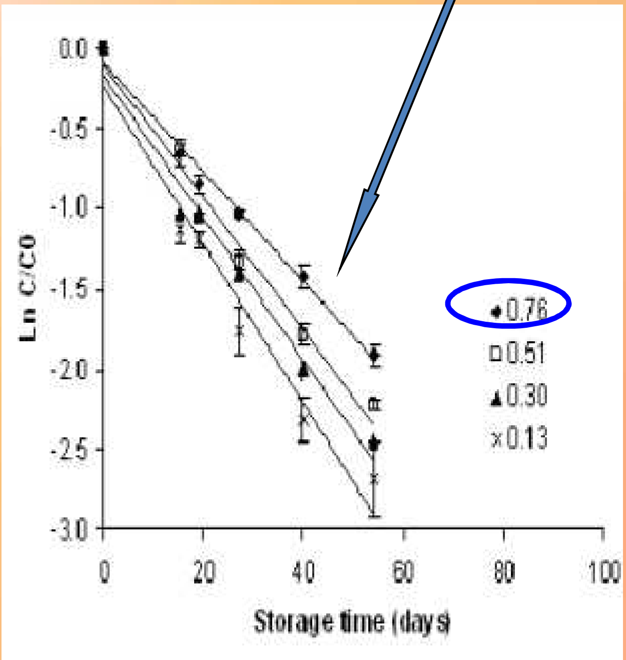
125 days at ambient temperature (recorded) in Uganda

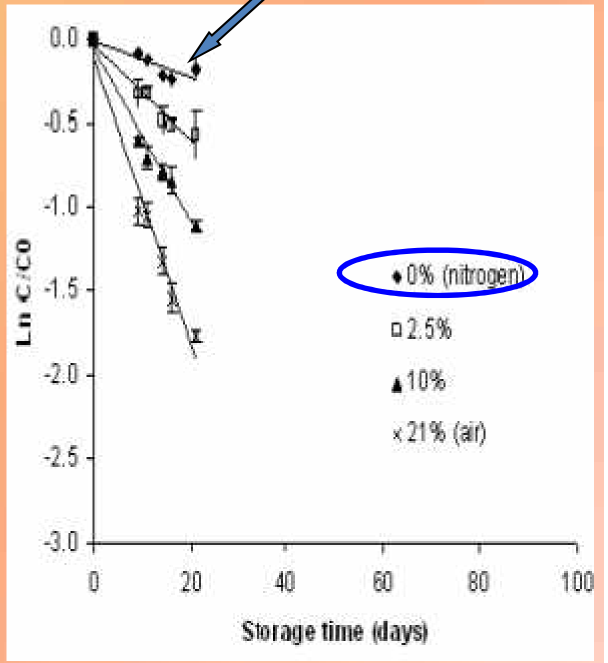
Chemical degradation of trans-B-carotene



Effect of temperature, aw and oxygen







Fewest carotenoid breakdown

- Lowest temperature
- Highest aw
- Lowest oxygen level

Conclusion for storage study

- Carotenoid degradation in dried sweet potato could be predicted
- Degradation was fast under ambient conditions (about 70% after 4 months).

Food preparation study

Mandazis

Chapati

Porridge

Bechoff, A., Poulaert, M., Tomlins, K.I., Westby, A., Menya, G., Young S., and Dhuique-Mayer, C. (2011) Retention and bioaccessibility of β-carotene in blended food from sub-Saharan Africa containing orange-fleshed sweet potato. ***Journal of Agricultural & Food Chemistry***, 59, 10373-10380.

Food preparation

- 2-week field study (Feb-Mar10) in Uganda funded by NRIF
- Interview of 10 chapatti processors and 10 porridge makers (households)
- Samples made by processors using the same initial ingredients (30% Ejumula flour)
- Explore the variability between processors and influence of cooking parameters on carotenoid retention

Findings: food preparation

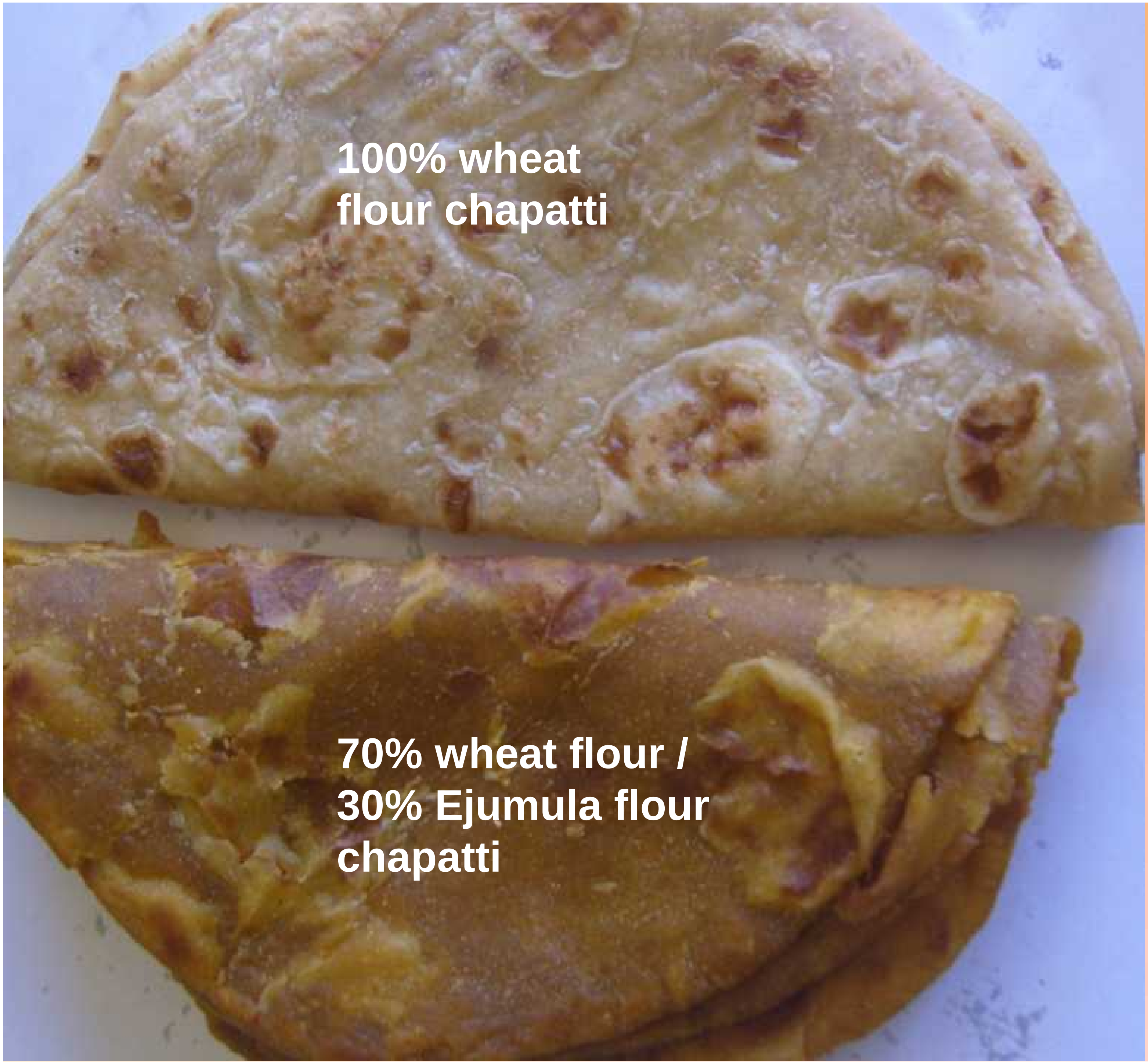
- Whilst the retention of trans-B-carotene varied in the methods of preparation (chapattis or porridge), there was no impact of method on carotenoid retention: 69-93% or 70-97% respectively for chapattis and porridge

- Both could provide significant provit. A to diet

OFSP[1] product	Fat (%)	BC content (µg.g-1)		BC bioaccessbility (%)		Unit	Recommended Daily Allowance (RDA)			
							Classical estimate[5]		Estimate taking into account bioaccessibility (in vitro digestion of product)[6]	
		All-trans-	13-cis-	All-trans-	13-cis-		%RDA child*	%RDA mother **	%RDA child*	%RDA mother **
Boiled OFSP	-	95.0 ±2.4	7.4 ±0.2	9.9 ±0.1	43.5 ±4.5	Puree portion (100g)	204	102	46	23
Porridge	-	8.7 ±0.3	1.2 ±0.1	16.3 ±0.9	30.3 ±6.1	1 mug (300g)	58	29	20	10
Chapati	7.4 ±1.0	31.5 ±1.4	2.5 ±0.5	72.7 ±5.4	96.2 ±5.9	1 chapati (100g)	68	34	100	50
Mandazi	3.3 ±0.2	32.9 ±1.7	3.7 ±0.4	49.0 ±3.0	98.1 ±7.7	~2 mandazis (90g)	73	36	75	34

*< 6 years (to meet 400RE); **pregnant or lactating (to meet 800RE)

Fat: better absorption of pVACs


100% wheat flour chapatti
70% wheat flour / 30% Ejumula flour chapatti

Overall conclusions/recommendations

- Losses can be as high as 70% after 4 months of storage but degradation can be predicted based on temperature; humidity and oxygen (air) data. **Packaging (i.e. under vaccum) will be critical to limit air into the product.**
- Losses can be as high as 30% during food preparation. Boiled sweet potato, or porridge and chapattis made from freshly dried SP flour could provide a significant amount of provitamin A to the diet (1/2 chapatti/day or 2 mugs of porridge/day or 100g of puree = 50% RDA).
- **Fat** (chapatis or mandazis) **is good** for increasing the absorption of pVACs and therefore the nutritional benefit.

Acknowledgments

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