HEALTHY BIRTH, GROWTH & DEVELOPMENT

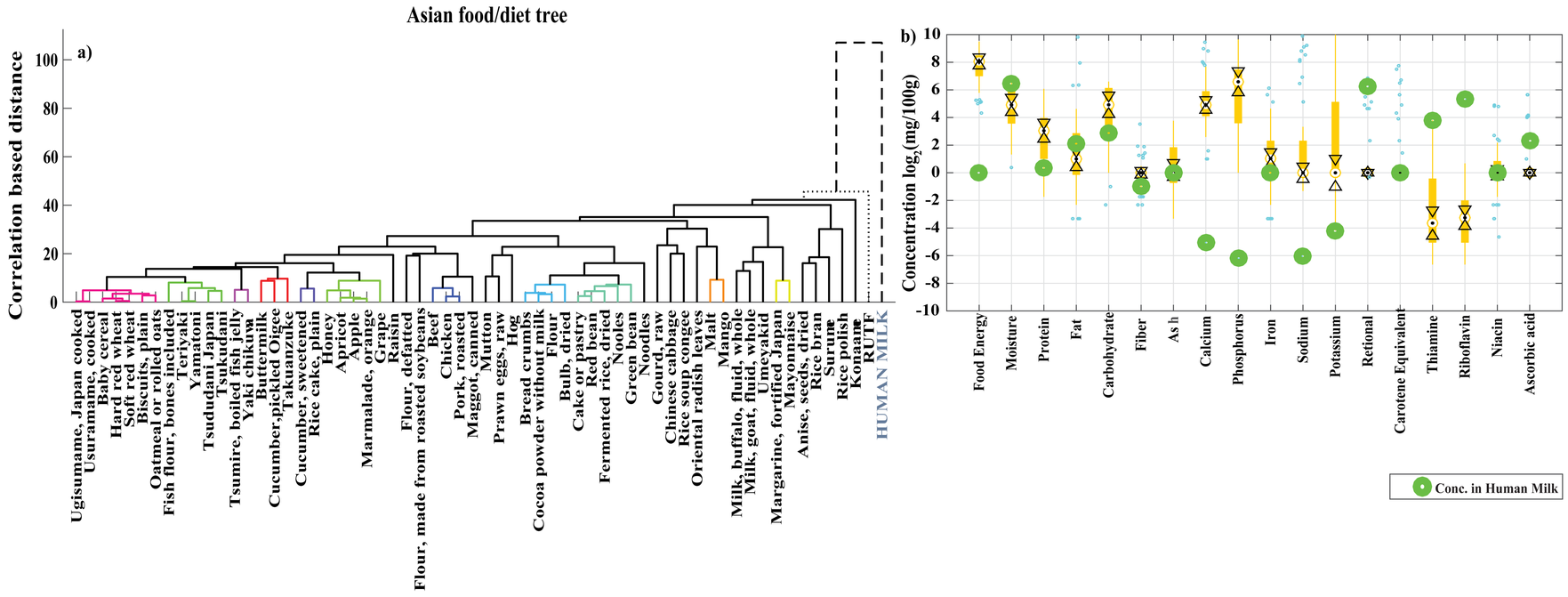
Identification of foods with optimal nutritional value through data mining

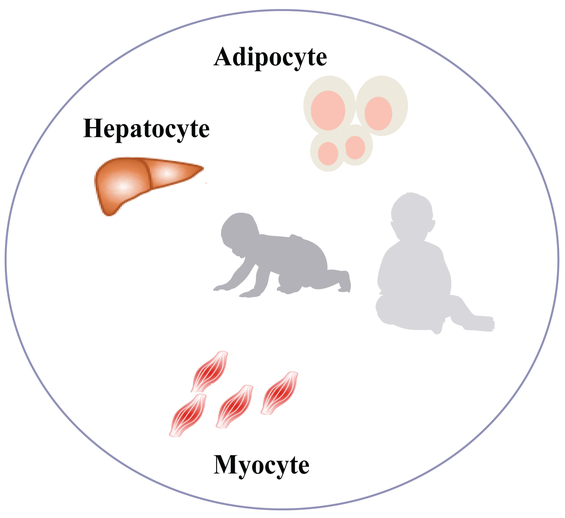
Partho Sen[1], Adil Mardinogulu[1], Jens Nielsen[1], GEM Team – Representing the Healthy Birth, Growth and Development knowledge integration (HBGD*ki*) community.

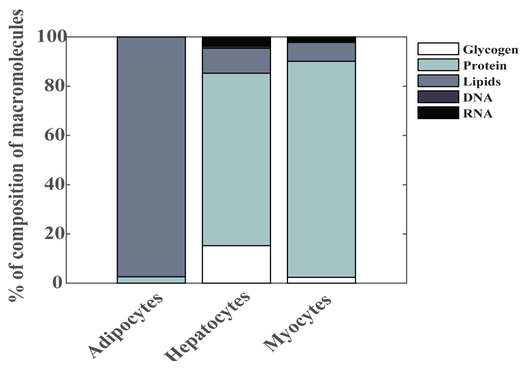
[1]Department of Biology and Biological Engineering, Chalmers University of Technology, Kemivägen 10, SE-412 96, Göteborg, Sweden.

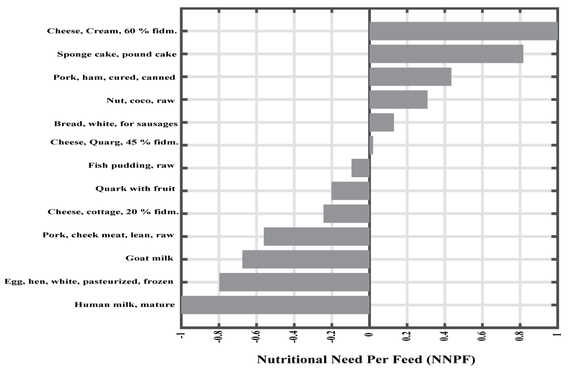
Objectives

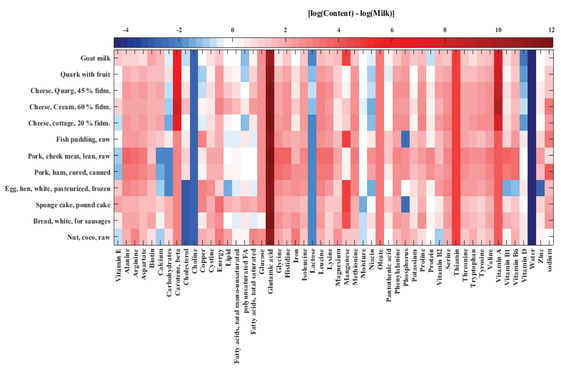
- Current feeding guidelines typically are based on tradition and speculation more than scientific evidence.
- Feeding guidelines often are more prescriptive than necessary regarding issues such as the order of foods introduced and amounts of specific foods to be given.
- The purpose of this study was to identify foods that have similar dietary content as human milk and also have optimal nutritional value for infants.

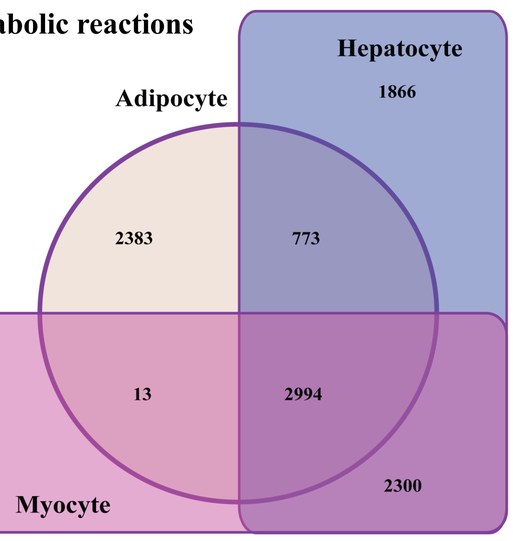


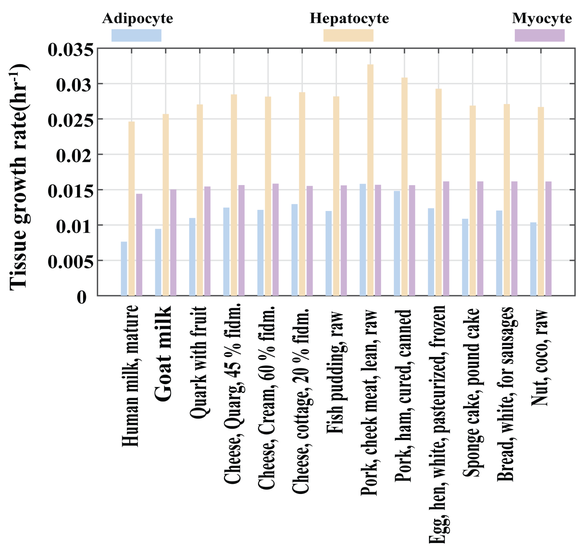












Methods

- We listed the traditional or most consumed foods from 4 continents.
- We compared these foods with human milk based on dietary content.
- A correlation-based distance measure (CBDM) metric was formulated for foods/dietary classification.
- We extended the search for similar foods using a computational framework coupled with a database of 8672 food/diets and 519 compounds with concentration profiles for food screening.
- Identified foods were reviewed to determine whether they could be given to infants.
- Selected foods were evaluated for ability to meet daily energy requirement of infants per feed, quantified by the *Nutritional Need Per Feed (NNPF)* score that was designed for this purpose.
- CBDM-identified foods were evaluated to determine whether they could meet the nutritional demands of infants.
- Genome-scale metabolic models (GEMs) were used to predict growth of liver (hepatocytes),[1] fat (adipocytes),[2] and skeletal muscle cells (myocytes) with these foods.
- Coefficient and content of growth equations for the models were constructed based on tissue composition data obtained between age 6 mo to 1 y.

Results

- There were marked differences between human milk and traditional foods in all food groups.
- Mineral and vitamin content in African diets were markedly low.
- Correlation-based screening showed 13 foods that had similar dietary content as human milk, including:
  - Goat milk (Spearman ρ = 0.936).
  - Quark with fruit (ρ = 0.927).
  - Cheese (ρ = 0.915-0.925).
- Frequency of feeding affected the daily nutritional demand of the infants.
- Hepatocytes, adipocytes, and myocytes had markedly low growth rates when fed only human milk. Flux balance analysis (FBA) and linear progamming was used for growth rate predictions.
- Breast-feeding alone could not sustain normal tissue growth after age 6 mo.
- Better growth was noted with foods such as cheese, quark with fruit, and protein diets such as pork and fish than human milk; however, the non-nutritional aspects of these foods were not evaluated.

Conclusions

- We identified 13 foods that have similar dietary content as human milk.
- These foods may aid in the formulation of infant formulas or may be given as complementary foods together with breast milk.
- This study suggests that dietary regimens in Africa should be revised to include foods that have high nutritional value.

Acknowledgement

This study is sponsored by the Bill & Melinda Gates Foundation, Healthy Birth, Growth, and Development initiative.

References

1. Mardinoglu, A. et al. Genome-scale metabolic modelling of hepatocytes reveals serine deficiency in patients with non-alcoholic fatty liver disease. *Nature communications* 5, 3083, doi:10.1038/ncomms4083, 2014.
2. Mardinoglu, A. et al. Integration of clinical data with a genome-scale metabolic model of the human adipocyte. *Molecular systems biology* 9, 649, 2013.

Sponsored by the Healthy Birth, Growth, and Development (HBGD) initiative representing Discovery & Translational Sciences, Integrated Development, Integrated Delivery, Nutrition, Agriculture, Water, Sanitation & Hygiene, Maternal, Newborn & Child Health, Enteric & Diarrheal Diseases, and Pneumonia Program Strategy Teams. HBGD*ki* was conceived of and is directed by shasha.jumbe@gatesfoundation.org.