Dry Chain Complements Disaster Preparedness, Food, Feed, Nutrition and Health Security to Alleviate Hunger and Poverty

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Aim

To bring awareness about the primary preventive "Dry Chain" intervention for disaster preparedness and to improve nutrition and food security and alleviate hunger and poverty.

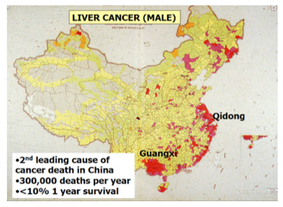
Introduction

Better food safety, security, nutrition and health are global concerns as the population increases to 10 billion by 2050. Agriculturalists have focused on increasing crop yields to meet growing demand for food. However, FAO estimates that about one-third of the total food produced, including dry foods, is lost or wasted, creating food safety and security concerns (FAO, 2011). Natural disasters like floods also pose quality management problems for food stakeholders. Medical research has called for improvement in dry food storage to minimize dietary exposure to mycotoxins (aflatoxins) that lead to poor nutrition and health problems including **liver cancer**. Low moisture content (MC) has long been identified as critical factor that has enabled safe product storage in **pharmaceutical**, **processed food** and **seed industries** in developed countries. However, an integrated approach to manage dry food products to minimize nutrient loss, insect and mold infestations prevalent in humid regions/seasons particularly in the developing countries is urgently needed.

Methods

Research data related to mycotoxin and dry food moisture contents (MC) were analyzed. Airport weather data were analyzed for India, Pakistan, China, Thailand, several African and South American countries. MC of dry food products were measured before the rainfall in breadbasket regions of India, Nepal and Thailand (Bradford et al., 2018). Re-generable desiccant was tested for drying horticultural and some agronomic seeds in south Asia and Africa known to have aflatoxins and insect prevalence. Natural drying was tested in Punjab and Telangana (India), south Nepal and north Thailand. Natural drying and hermetic packaging was demonstrated in earthquake-hit village in Nepal.

Note the prevalence of liver cancer cases in humid regions of Peoples Republic of China.



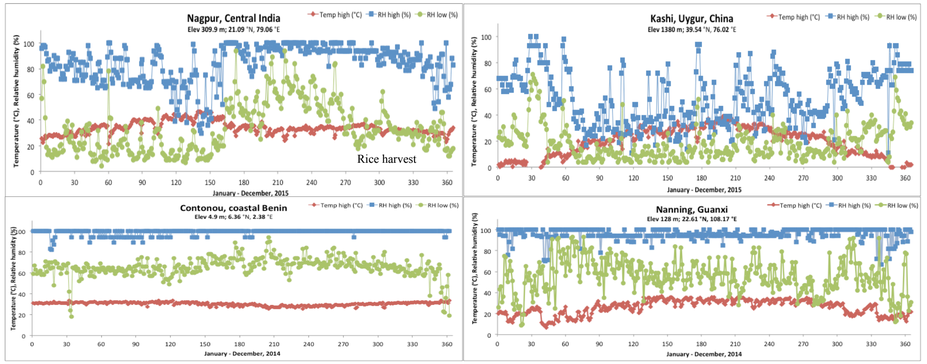
Cohort Study of Liver Cancer in P.R.C.: Viral-Chemical Interactions

- 18,244 urine and blood samples collected from healthy men age 45-65
- 50 liver cancer cases and 247 controls
- Urinary aflatoxin biomarkers measured in blinded samples
- HBV status determined for each subject

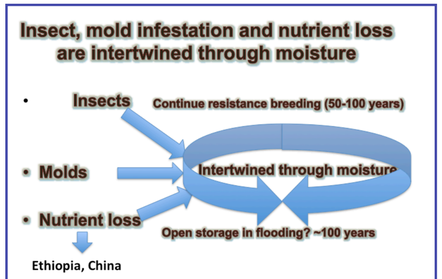
Lancet 339: 943-946, 1992 and *C.E.B.P.* 3: 3-11, 1994

BIOMARKERS: HBsAg AND URINARY AFLATOXINS	RELATIVE RISK FOR LIVER CANCER
NO BIOMARKERS DETECTED	1.0
HBV (YES) AFLATOXIN (NO)	7.3
HBV (NO) AFLATOXIN (YES)	3.4
HBV (YES) AFLATOXIN (YES)	60.0

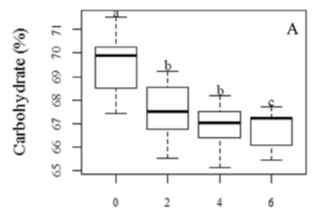
http://www.nutritioninnovationlab.org/event-post/2013-scientific-symposium/



Upper panels: Low daytime humidity suitable for drying food products were observed in the long dry season in breadbasket regions and hinterland locations. **Lower panels:** Continuous high humidity was observed during rainy seasons and in coastal locations causing high MC in stored dry foods. Biennial rainfall patterns in Sub Saharan Africa (not shown) also complicate drying of dry food products.

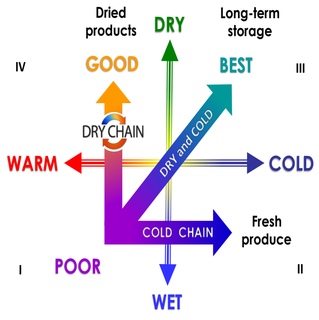


Dry food product moisture content is intimately related to reducing loss/toxicity and improving nutrition.



Initial MC at farms in Ethiopia ranged from 19-25% which declined to 11-13% during 4-month storage concomitant with decline in carbohydrate. *J Stored Prod Res.* 2017; **70**: 7–17.

Dry Chain minimizes nutrient loss, mold and insect infestation in storage



Cold Chain: High moisture and continuous cooling needed to minimize loss of shelf life.

Dry Chain: Dry to safe "processing moisture content" and store in hermetic containers.

Storing cold after drying is best to minimize nutrient loss, but warm conditions also work for medium-term hermetic storage.

When drying is feasible in dry seasons, food products should be dried during daytime (low RH) and covered with a tarp at nights (high RH) until achieving safe or processing MC and packaged into hermetic containers to prevent rehydration until processed or consumed.

Results

Nutrient and food loss occurs in storage due to moisture-induced infestation by molds and insects. Toxigenic fungi producing mycotoxins can grow in storage and cause food safety concerns in humid seasons/regions. High MC of foods favors this damage, pointing to moisture as the primary storage culprit. Pharmaceutical, processed food and seed industries protect dry products from moisture during storage and transport. There is lack of awareness about interdisciplinary Dry Chain intervention to complement toxin reduction strategies to address nutrition in LMIC.

Molds and insects cause extensive nutrient and dry food losses

http://kathmandupost.ekantipur.com/news/2015-07-20/wfp-destroys-spoilt-rice-in-gorkha.html

WFP/UNDP could not maintain quality and dumped dry food meant for earthquake relief in Nepal.

India

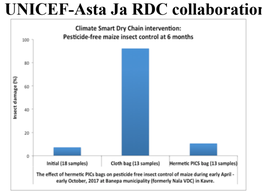
Thailand

Annual floods damage foods in South Asia

Global problems of porous packaging

Repeated sun drying before monsoon reduced wheat MC from 10% to 6% at south Nepal.

Nutrients were saved through pesticide-free insect control in UNICEF-Asta Ja RDC collaboration.



Courtesy: UNICEF-Asta-Ja RDC, Nepal

Dry Chain

Moisture mantra in pesticide-free Dry Chain

Dry food products sooner to 'suitability' for traditional processing MC (13-15%) and use *hermetic* (air tight) packaging

Monitor quality/aflatoxins in food/feed value chain

Dry season:

Air dry and *hermetic* pack

Rainy season:

Commodity: Medium heat/ desiccant-dry & *hermetic* pack

Seeds: Low heat/desiccant-dry & *hermetic* pack

www.dryingbeads.org

Conclusions

Moisture, not temperature, is the main culprit for infestation of stored dry foods by toxigenic molds and insects. Porous packaging should be replaced by hermetic containers to maintain desired MC. When food products are dry at harvest (i.e., at or below processing moisture content), hermetic packaging alone is sufficient. During rainfall/humid seasons, artificial (heated air (Saha et al., 2017) or desiccant (Bradford et al., 2018) drying followed by hermetic packaging is needed to minimize nutrient loss and prevent mycotoxin accumulation in the dry products. Implementation of the pesticide-free dry chain soon after harvest could: (i) enable food disaster preparedness; (ii) improve quality grain reserves; alleviate hunger and poverty; (iii) minimize toxin transfer to high moisture meat and dairy products; and (iv) reduce incidence of liver cancer and malnutrition.

Acknowledgments

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