

DIRECTORATE OF ADVANCED STUDIES
EVENT CATALOGUE
2021

28TH SEMINAR OF DAS EVENTS CALENDAR – 2021

MILK ADULTERATION AND IMPACT ON HUMAN HEALTH



28th Seminar (Online through ZOOM) of DAS Events Calendar

**MILK ADULTERATION AND IMPACT
ON HUMAN HEALTH**

Presenter: Dr. S. Maryam Hussain

Assistant Professor, Department of Livestock Production & Management

Dated: Thursday, November 11, 2021 Time: 02:00 p.m. - PKT GMT+5

ZOOM Meeting ID: 955 408 3170 - Passcode: 67890

Organized By: Directorate of Advance Studies, PMAS-AAUR

ACTIVITIES

Milk adulteration and its impact on Human Health

Dr. S. Maryam Hussain
Assistant Professor
Livestock Production and Management



CONTENTS

Historical perspective of adulteration
Causes of adulteration
Categories of adulteration
Types of adulteration
Methods of adulteration
Global milk Scenario
Milk statistics of Pakistan
Milk, Why we should drink it?

- Milk adulteration map
- Common adulterants
- Health concerns
- Toxicological effects of adulterants
- Dangerous milk identification
- Famous good quality brands
- Food laws
- References

Historical Perspective

At least as early as 300,000 years ago, humans harnessed fire to cook and conserve meat and, later, determined that salt could be added to preserve meat without cooking.

Over time, the act of adulterating food for economic gain began to emerge.

During the 18th and 19th centuries, United States shifted from an agricultural to an industrial economy the debasement of food for profit became rampant.

Adulterant usage was first investigated in 1820 by the German chemist Frederick Accum, who identified many toxic metal colorings in foods and drinks.

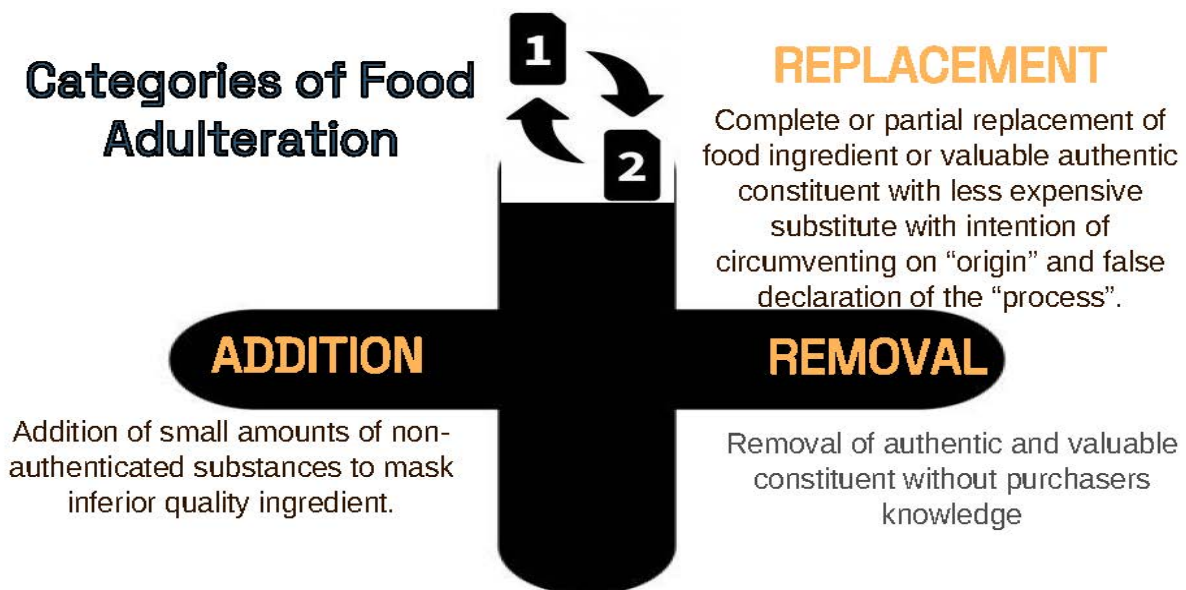
“It is reported that about, 22% of foods are adulterated annually. Globally, around 57 % of people have developed health problems due to consumption of adulterated and contaminated foods”

(Devrani and Pal, 2018)

CAUSES OF FOOD ADULTERATION:

Cause	Reason
Demand and supply Gap	Large population
Financial greed	Passion for more profit
Physical nature of milk	Aqueous and opaque nature of milk can accommodate many adulterants.
Perishable nature of milk	The unscrupulous producers /vendors use preservatives neutralizers to prolong the shelf life.
Low purchasing power of consumer	Encourages the supplier to adulterate milk and sell at cheaper rate
Unorganized Dairy Industry	Milk is procured and traded by unorganized dairies, which freely adulterate the milk.
Lack of vigilance	Lack of Human resource
Inadequate technology support	Lack of user-friendly & low cost technology for testing, analysis, storage, transportation etc.

Categories of Food Adulteration



Types of Adulteration



1. Intentional adulteration:
water, sand, stones, chalk, coal tar dyes, urea, melamine.
Milk, honey, olive oil, saffron, orange/ apple juice and coffee.



2. Accidental adulteration:
Improper processing, handling, storing, transporting and marketing. e.g Residues of pesticides and insecticides, droppings and larvae of animals and insects, tin from canned products.

3. Incidental adulteration
Metallic contamination usually occurs through our environment
Lead, arsenic, mercury, cadmium.

METHODS OF FOOD ADULTERATION:

- Mixing: Mixing of clay, stones, pebbles, sand, marble chips, etc.
- Substitution: Cheaper and inferior substances being replaced wholly or partially with good ones.
- Concealing quality: Trying to hide the food standard. E.G. adding captions of qualitative food to low quality for selling.
- Decomposed food: Mainly in fruits and vegetables. The decomposed ones are mixed with good ones
- Misbranding/ False labels: Includes duplicate food stuffs, changing of manufacture and expiry dates.
- Addition of toxicants: adding non-edible substances like argemone in mustard oil, low quality preservatives, colouring agents, etc.

ADULTERANTS

- Unhygienic water
- Chalk powder
- Soap powder
- Hydrogen peroxide
- Urea

• Papaya seeds

MILK



HARMFUL EFFECTS

- Food poisoning
- Heart problems
- Cancer
- Vomiting
- Nausea
- Liver disorders
- Stomach disorders

BLACK PEPPER



OIL



HARMFUL EFFECTS

- Epidemic dropsy
- Severe glaucoma

GHEE

- Vegetable oil
- Animal body fats



HARMFUL EFFECTS

- Anaemia
- Enlargement of Heart

CHILLY POWDER

- Brick powder
- Saw dust



HARMFUL EFFECTS

- Stomach problems
- Artificial colors can cause cancer

TURMERIC POWDER

- Yellow aniline dye
- Non-permitted colourants like metanil yellow



HARMFUL EFFECTS

- Carcinogenic
- Stomach disorders



MILK

ADULTERANTS

- Unhygienic water
- Chalk powder
- Soap powder
- Hydrogen peroxide
- Urea

MILK



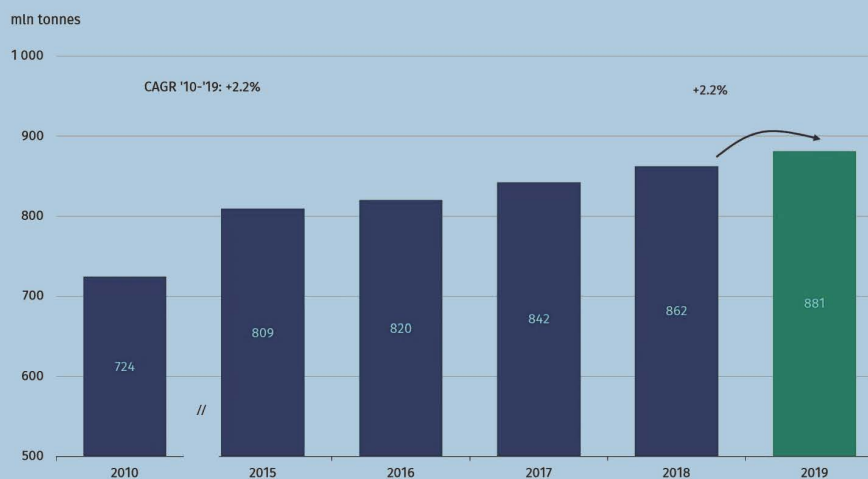
HARMFUL EFFECTS

- Food poisoning
- Heart problems
- Cancer
- Vomiting
- Nausea

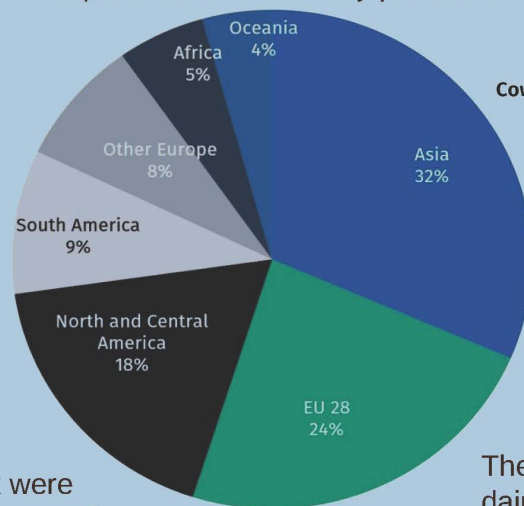
- ✓ In World, 881 million tons of milk. Dairy industry serves > 7 billion consumers and provides livelihood for 1 billion people.
- ✓ Milk production in 2030 will reach 1168 million tons.

GLOBAL MILK SCENARIO

Global milk production – all species



More than 80% of the world's population, or about 6 billion people, regularly consume liquid milk or other dairy products.



Cow's milk production % per world region

714 billion kg of cows milk were produced in 2019. Asia is currently the world's leading region for cows milk production at 32 %

There are about 133 million dairy farms globally. 9% of global milk production is traded annually.

Milk status as per economic survey of Pakistan

Ranking

Among top five dairy hubs of the globe; after India, USA and China. Pakistan is at 4th position followed by Brazil.

Breeds

High yielding buffalo and cattle breeds i.e., Nilli Ravi, Kundhi and Aza Kheli buffaloes and Red Sindhi.

Largest contributor

Sahiwal cattle contributes about 95% in total milk production.

In, 2019-20, the Gross Milk Production of Pakistan

Animals	Prod. (litres)
Cows	22,508 thousand
Buffaloes	37,256 thousand
Sheep	41,000
Goats	965,000
Camels	920,000
	61,690 thousand tonnes (61.6 billion)

Human consumption - Only 50,000 thousand tonnes

- 20 % - wastage
 - 15 % - transportation + lack of chilling facilities
 - 5 % - suckling calf nourishment

Pakistan: land of small dairy farms



5%

Nestle, Friesland Campina, Engro and Cargill



15%

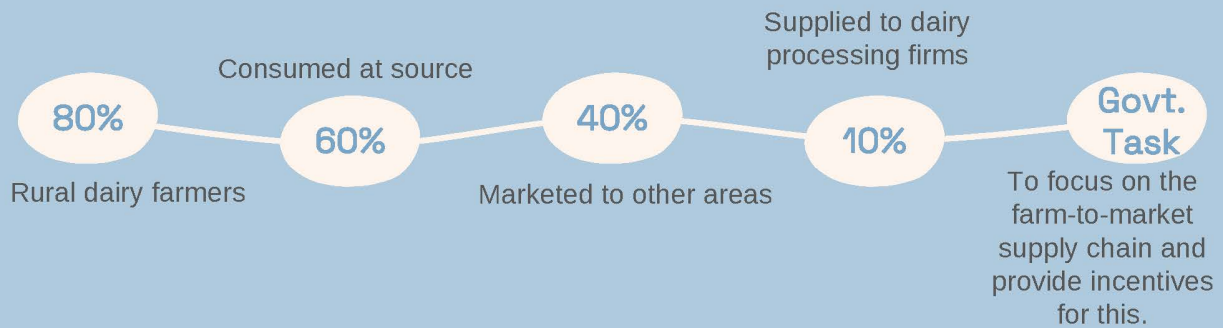
Nishat, Dairyland, Friendship, Sharif, Sapphire and Dada Dairies.



80%

Smallholder dairies with a few cattle or buffalo and small-scale vendors and processors

Normal practice in Pakistan by private sector in both rural and urban area



Benefits of Milk

- ✓ Glowing Skin
- ✓ Beats stress
- ✓ Soothes Tummy
- ✓ Healthy Bones and Teeth
- ✓ Healthy Body
- ✓ Wholesome body development



WHY SHOULD YOU DRINK MILK?

**ONE CUP (240 ML) OF
WHOLE MILK WITH
3.25% FAT PROVIDES:**



Daily Value

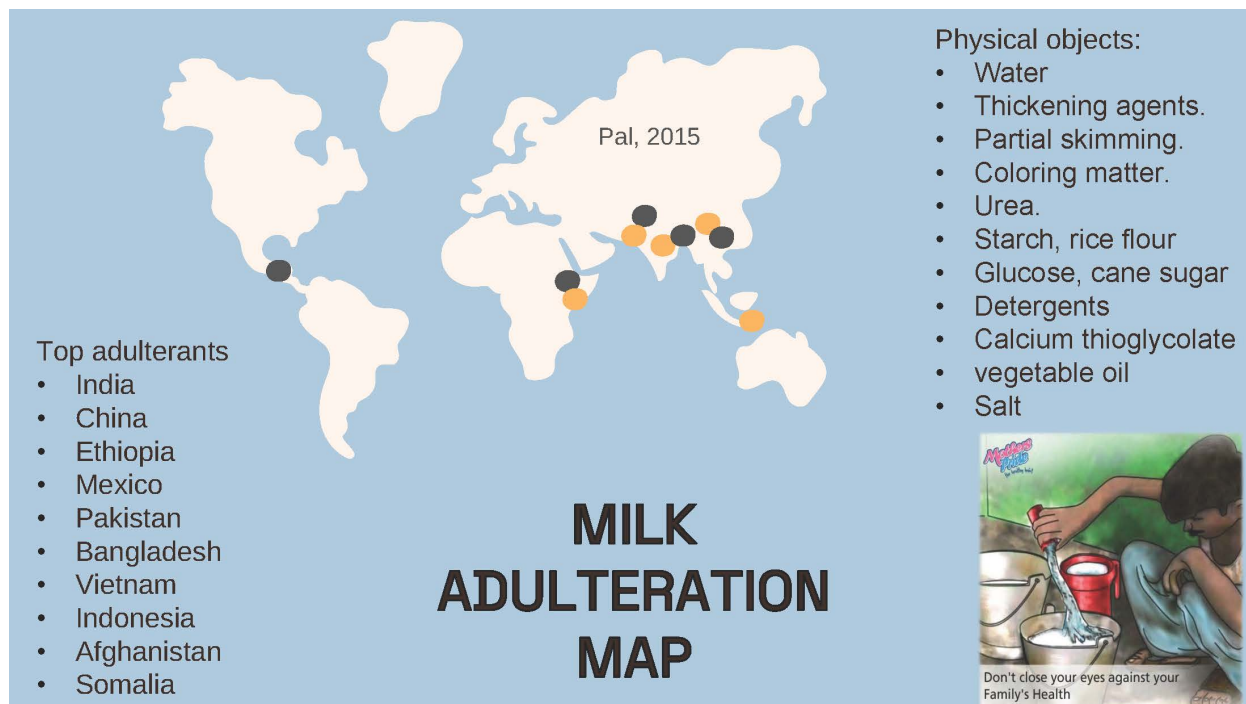
- Calcium (25%): Build & maintain strong bones + teeth
- Phosphorus (20%): Strengthens bones
- Potassium (8%): Regulates fluid balance and helps maintain normal blood pressure
- Vitamin A (15%): Promotes good vision & healthy skin
- Vitamin D (15%): Promote the absorption of calcium
- Vitamin B5 (20 %): Convert food into energy
- Vitamin B2 (Riboflavin (35%): Supports body growth, red blood cell production, and metabolism
- Vitamin B3 (Niacin (10%): Proper circulation

AWESOME DRINK but.....

In a country where more than 90% of the dairy market is informal and unregulated, adulteration is an alarming practice and poses serious health risks for consumers and for expectant mothers and children, particularly.

- ❖ Some of the adulterants are carcinogenic in nature.

More than 45% of children are malnourished in Pakistan



Common Adulterants

- Water
- Separated milk.
- Thickening agents.
- Partial skimming.
- Coloring matter.
- Unusual adulterants e.g. Urea, ammonium sulphate. (enhance heat stability).
- Thickening agents - starch, rice flour, arrowroot
- Constitutional agents - glucose, cane sugar, sodium salts.
- Detergents - enhance the cosmetic nature of water diluted milk.
- Calcium thioglycolate - Milk whitening and to maintain the protein level.
- Vegetable oil and/or mobil oil - Increase the fat level.
- Sodium salt - Added to already diluted milk to enhance the ash & specific gravity.

Synthetic milk formula

Good and pure milk

Its own distinctive features and appearances whereas the adulterated milk lacks those.



Milk powders

In many places, cheap quality of milk powders are also used which simply vanishes all signs of artificial milk.

Many times, water and other chemicals are also used.



Urea, Milk powder and oil

A paste is prepared by mixing all these by blending or grinding which give it appearance as milk.



Commonly

These milks are mostly used by small tea stalls and hotels.

The World Health Organization (WHO) has warned that if milk adulteration is not halted, a major portion of the population might face life-threatening diseases by the year 2025.

The severity of milk contamination and adulteration will depend upon how it got contaminated and the kind of adulteration products used.



Health Concerns

- Blood pressure, cholesterol, diabetes
- Obesity and Heart problems
- Diarrhea, Viral fever
- Hepatitis
- HIV
- Paralysis
- Cancer
- Anemia
- Abortion
- Brain damage
- Blurred vision, Blindness



TOXICOLOGICAL EFFECTS OF ADULTERANTS

FORMALIN

- Biological mutation and reproduction complication. On toxicity it causes tumors formalin causes CNS disorders and also irritates nose, throat and lungs, it cause cancer and may lead to coma.

UREA

- Potential symptoms - Burning sensation in throat and chest; cough, dyspnea, exercise-induced asthma (one case); redness, in eyes and skin, headache; nausea, vomiting, lung damage-fibrosis, inflammation (HE11). Affected organs are respiratory system, skin, eyes.

AMMONIUM SULPHATE

- The product has low toxicity, on skin contact prolonged contact may cause some irritation. On ingestion large quantities give rise to gastro-intestinal disorders. On inhalation high dust concentration of air-borne material may cause irritation of the nose and upper respiratory tract with symptoms as sore throat and coughing. Inhalation of some decomposition gases may cause irritation and corrosive effects on the respiratory system. Some lungs effect may be delayed.

Hydrogen Peroxide

- An overuse of H_2O_2 in milk can cause DNA cells damage, mutation and prevent them from replicating, hence leading to premature aging.
- Skin to dry out.
- Gums and teeth irritation.
- Throat soreness.

Vegetable Fat

- Hepato-toxicity and liver cirrhosis.

Starch

- Eyes, skin, mucous membrane Irritation, cough, dermatitis.

Soap

- Stomach and kidneys issues.

Mineral oil

- Cancers

Sugar

- Suppress immune system, cause hyperactivity, anxiety, inability to concentrate, crankiness, ovarian and colon cancer, Cu deficiency, hormonal imbalances, increases triglycerides and reduces high-density lipoproteins, aggravate premenstrual syndrome, Alzheimer's disease.

Salt

- ✓ Muscle cramps, Duodenal ulcer, neurological problems, dizziness, Heartburn, Gastric cancer, Hypertension, Osteoporosis, cardiac enlargement, exercise – induced asthma.

Overview of milk fraud incident types and their impact on nutrition

Adulterant	Public health risk
Water	- Acute malnutrition (potential stunting, underweight, wasting) and nutrition-related child mortality. - Severe cases of malnutrition have resulted in death.
Skimmed milk powder	While the protein and lactose content is similar to whole milk, skim milk contains low levels of fat and fat soluble vitamins, which might impair growth and development in children.
Sugars (sucrose/ glucose)	- It can cause diarrhoea. - Can pose a risk for diabetics or borderline patients who might be consuming excess sugar as will raise their blood sugar levels.
Vegetable oil.	Replacement of milk fat with vegetable oil for economic gains
Urea	Increased profits by blending with other ingredients for synthetic milk.
Melamine	- Toxic poisonings - Kidney stones - Hypertension - Edema - Acute renal failure - Bladder cancer - Severe cases led to death

Adulterant	Public health risk
Ammonium sulfate	-Nausea -Vomiting -Diarrhea -Adverse effects on GIT, respiratory system, and skin -Sensory disturbances
Formaline	-Vomiting -Diarrhea -Low body Temp. -Dermatitis -Mood and balance alterations -Abdominal pain -Liver and kidney -Impaired vision
Hydrogen peroxide	-Nausea -Vomiting -Gastritis -Lethargy
Salicylic acid	-Gastric irritation -Bleeding -Diarrhea -Severe cases of poisoning may result in death.

Boric acid	-Nausea -Vomiting -Headache -Diarrhea -Severe colic -Kidney damage
Benzoic acid	-Nausea -Headache -Asthma -Urticaria -Pseudoallergy -Hyperactivity and behavioral disorders. -Individuals who already allergy sufferers, particularly those with asthma.
Caustic soda (NaOH)	-Vomiting -Severe cases cause burns on the lips, tongue, harms the mucosa of esophagus.
Detergent	-Gastro-intestinal complications, i.e. abdominal pain and vomiting -Hypotension -Respiratory irritation -Cancers
Neutralizers (CaCO ₃)	-Disrupt hormone signaling that regulate development and reproduction -GIT problems as vomiting and diarrhea

Adulterants Detection Methods

Urea	Potentiometric biosensor, pH measurement, NH ₄ ⁺ sensitive CHEMFET based sensor, pH sensitive field effect transistor.
Water	Frequency admittance measurement, E-nose Electrical conductivity, Ultrasonic transmitter receiver system, Freezing point osmometry and freezing point, cryoscopic method
Colour	Capillary electrophoresis
Neutralizers	Conductivity or pH measurement
Milk powder	FAST (Fluorescence of Advanced maillard products and Soluble Tryptophan)
Antibiotics	Electrical conductivity, BRT Test, Spot Test, SNAP test, Chromatography, Biosensor array based on surface plasma on resonance (SPR), E-Nose.
Preservatives	Conductivity, Impedance, Capacitance, Piezoelectric transducer, E-Tongue

THIS IS HOW YOU SPOT		
NATURAL		SYNTHETIC
Taste	Slightly sweet	Bitter
Colour	White	White
Texture	No Soapy feeling if rubbed between fingers	Soapy feeling if rubbed between fingers
Effects of heating	No changes, remains white	Turns yellowish when boiled
Effect on storage	No change in colour	Turns yellowish after a while
If urea present	Weakly positive (light yellow)	Highly positive (intense yellow)

The Punjab Food Authority (PFA) has released the complete list of all companies and their milk products, which are healthy for consumption.

PCSIIR conducted the analysis of various brands based on the following categories:

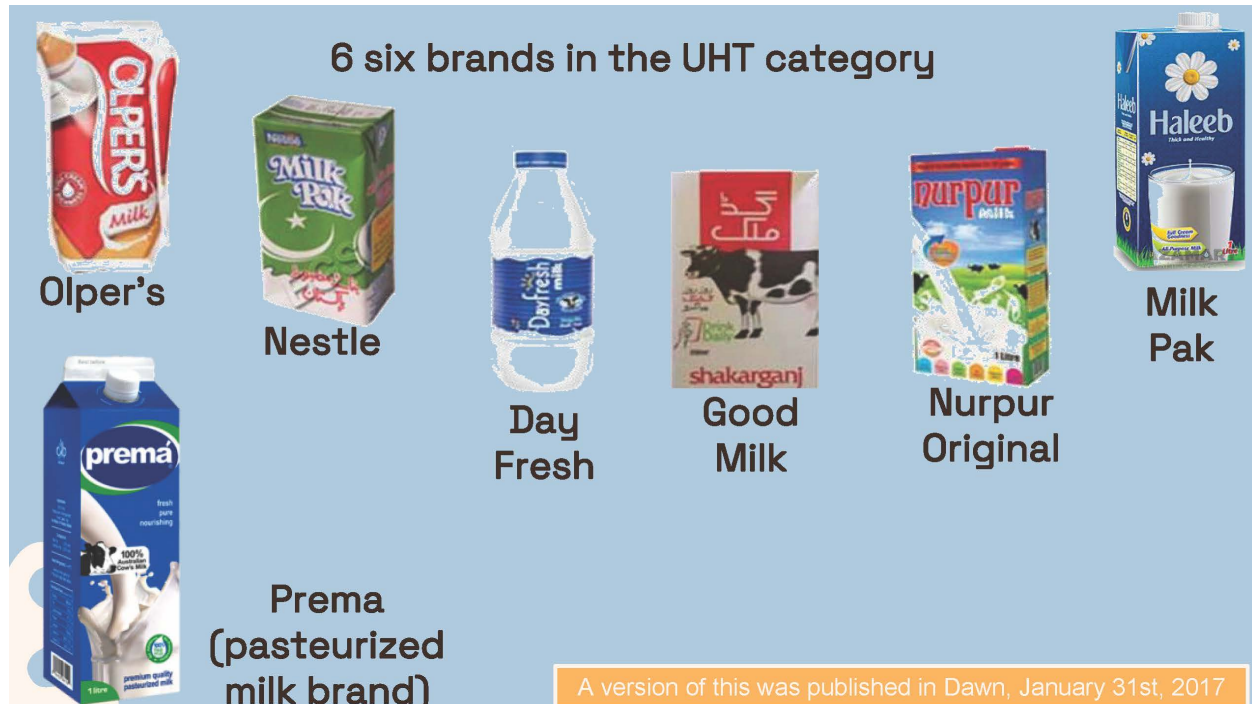
Passing Brands:

UHT/Tetra Brands:

Haleeb, Olpers, Nurpur Milk, Nestle Milk Pack, Nestle Nesveta, Day Fresh, Good Milk.

Natural Pasteurised Category:

Anhaar Milk, Daily Dairy, Doce Milk, Gourmet Milk, Nutrivo Milk, Achaa Milk, Adams Milk, Malmo Milk, Prema Milk, Pack Fresh.



**Not all poverty comes from wealth,
some come from deteriorated
health conditions too.**

**Being poor in terms of health is
the most threatening type of
poverty.**

- ✓ China's "big head disease" scandal in 2004, infants were fed fake formula. A symptom of acute malnutrition, lack of flesh on the limbs and torso, which appear to shrink in comparison with the cranium (BBC NEWS 2004).
- ✓ Nitrate cause blue baby syndrome, in formula- fed infants less than 3 month of age.

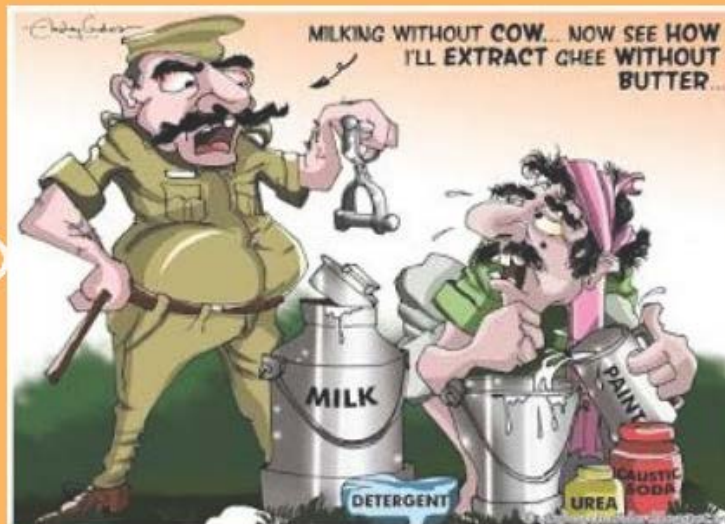
MITIGATION MEASURES FOR ADDRESSING FOOD ADULTERATION:

- Proper surveillance of the implementation food laws.
- Monitoring of the activities with periodical records of hazards regarding food adulteration.
- Periodical training programmes for Senior Officer/Inspector/Analysts for food safety
- Consumer awareness programmes organized by holding exhibitions/ seminars/ training programmes and publishing pamphlets.
- Strict actions regarding the punishment for those who are involved in food adulteration.
- Support from International govt. for implementation of food laws.

FOOD LAWS

- 23. Selling food against the law - imprisonment for upto 6 months and upto 1 million Rs.
- 23A. Offence by large scale manufacturer – imprisonment for upto 5 years, upto 2 million Rs.
- 23B. Substandard or misbranded food –Imprisonment for upto 6 months, upto 1 million Rs.
- 23C. Unsafe food
 - (a) imprisonment for upto 6 months and upto 1 million Rs.
 - (b) imprisonment for upto 3 years and fine upto 1 million Rs.
 - (c) imprisonment for life and fine upto 3 million Rs.
- 23D. Unhygienic or unsanitary conditions– mprisonment for upto 6 months, upto 1 million Rs.
- 23E. Business without licence– imprisonment for upto 1 year and upto 500,000 Rs.
- 23F. False advertisement– imprisonment for upto 6 months and upto 2 million Rs.
- 23G. False labeling– imprisonment for upto 6 months and upto 1 million Rs.

GOVERNMENT TASK



REFERENCES

- ✓ "Research Can Lead To Longer Shelf Life For Dairy Products" (<http://www.sciencedaily.com/releases/2002/12/021223084204.htm>). Sciencedaily.com. 2002-12-23. Retrieved 2010-08-28.
- ✓ Detect Adulteration in Milk: Empowering Consumers to Test Themselves (<http://cgsiindia.org/2013/05/detectadulteration-in-milk-empoweringconsumers-to-test-themselves/>).
- ✓ Henriksen J, (2009) "Milk for Health and Wealth". (<ftp://ftp.fao.org/docrep/fao/011/i/0521e/i/0521e00.pdf>) FAO Diversification Booklet Series 6, Rome.
- ✓ Schultz, Madeline (April 2012) fluid milk profile (<http://www.agmrc.org/commodities/products/livestock/dairy/fluid-milk-profile/>). Iowa State University.
- ✓ T. Matsuoka (2004). Detection of adulterants in milk using near infrared spectroscopy. J. Food Sci. Tech. 41(3): 313-316.
- ✓ Borin, A., M. F. Ferrao, C. Mello, D. A. Maretto and R. J. Poppi (2006). Least-squares support vector machines and near infrared spectroscopy for quantification of common adulterants in powdered milk. Analytica Chimica Acta. 579:25-32.
- ✓ Tipu, M. S., I. Altaf, M. Ashfaq, S. Siddique (2007). Monitoring of chemical adulterants and hygienic status of market milk. Handbook published by Quality Control Laboratory, Lahore, Pakistan. pp.: 7.
- ✓ Jha, S. N. And T. Matsuoka (2004). Detection of adulterants in milk using near infrared spectroscopy. J. Food Sci. Tech. 41(3): 313-316.
- ✓ Sengar, M. S. (2007). Milk adulteration on rise in Agra. Friday, November, 07, India. Accessed from www.google.com.
- ✓ Anonymous, (2012). Introduction to dairy science and technology: milk history, consumption, production, and composition. International Dairy Federation, Bulletin 423/2007. Accessed from: <http://www.foodsci.cuoguelph.ca/dairyedu/intro.html>.
- ✓ Bansal, S., Singh, A., Mangal, M., Mangal, A. K., & Kumar, S. (2015). Food adulteration: Sources, health risks, and detection methods. Critical Reviews in Food Science and Nutrition, 57(6), 1174–1189.
- ✓ Banerjee, D., Chowdhary, S., Chakraborty, S., & Bhattacharyya, R. (2017). Recent advances in detection of food adulteration. Food Safety in the 21st Century, 145–160.
- ✓ Schieber, A. (2018). Introduction to Food Authentication. Modern Techniques for Food Authentication 1-21 link.springer.com/chapter/10.1007/978-3-030-28034-5_2
- ✓ [Balancenutrition.in/blog/health-reads/health-diet/how-does-food-adulteration-impact-our-health](http://www.balancenutrition.in/blog/health-reads/health-diet/how-does-food-adulteration-impact-our-health).
- ✓ indiastudychannel.com/resources/172754-Adulteration-and-Harmful-effects-of-Food-Adulteration.aspx.
- ✓ vikaspedia.in/health/health-campaigns/beware-of-adulteration/methods-for-detection-of-common-adulterants-in-food.
- ✓ 8. scielo.br/scielo.php?script=sci_arttext&pid=S0101-2061201900020034. Schell LM, Gallo MV and Cook K, What's NOT to eat – food adulteration in the context of human biology. Am J Hum Biol 24:139–148(2012).
- ✓ Lakshmi V, Food adulteration. IntJSciInventToday1:106–113 (2012). 3 US Legal Inc., Adulterated food law & legal definition [Online] (2014). Available: <http://definitions.uslegal.com/a/adulterated-food/> [15 July 2014].
- ✓ Li JH and Ko YC, Plasticizer incident and its health effects in Taiwan. Kaohsiung J Med Sci 28:S17–S21 (2012). <https://doi.org/10.1016/j.kjms.2012.05.005>.
- ✓ Chen Y, Fu S, Huang J, Cheng H and Kang J, A review on the response and management of the plasticizer-tainted food incident in Taiwan. J Food Drug Anal 21:242–246 (2013). <https://doi.org/10.1016/j.jfda.2012.11.001>.
- ✓ Carlson PO, Cohan AN and Gray JC, Clouding agent. US Patent 3658552 (1972).
- ✓ Crinnion WJ, Toxic effects of the easily avoidable phthalates and parabens. Altern Med Rev 15:190–196 (2010).

- ✓ Van Holderbeke M, Geerts L, Vanermen G, Servaes K, Sioen I, DeHenaauw S et al., Determination of contamination pathways of phthalates in food products sold on the Belgian market. *Environ Res* 134:345–352 (2014). <https://doi.org/10.1016/j.envres.2014.08.012>.
- ✓ Sioen I, Flerens T, Van Holderbeke M, Geerts L, Bellemans M, DeMaeyer M et al., Phthalates dietary exposure and food sources for Belgian preschool children and adults. *Environ Int* 48:102–108 (2012). <https://doi.org/10.1016/j.envint.2012.07.004>.
- ✓ Latini G, De Felice C and Verrotti A, Plasticizers, infant nutrition and reproductive health. *Reprod Toxicol* 19:27–33 (2004). <https://doi.org/10.1016/j.reprotox.2004.05.011>.
- ✓ Wu MT, Wu CF, Wu JR, Chen BH, Chen EK, Chao MC et al., The public health threat of phthalate-tainted foodstuffs in Taiwan: the policies the government implemented and the lessons we learned. *Environ Int* 44:75–79 (2012).
- ✓ Lu J, Plasticizer event in Taiwan. *J Formos Med Assoc* 110:553–554 (2011). <https://doi.org/10.1016/j.jfma.2011.07.002>.
- ✓ Yen TH, Lin-Tan DT and Lin JL, Food safety involving ingestion of foods and beverages prepared with phthalate-plasticizer-containing clouding agents. *J Formos Med Assoc* 110:671–684 (2011). <https://doi.org/10.1016/j.jfma.2011.09.002>.
- ✓ Yang J, Hauser R and Goldman RH, Taiwan food scandal: the illegal use of phthalates as a clouding agent and their contribution to maternal exposure. *Food Chem Toxicol* 58:362–368 (2013). <https://doi.org/10.1016/j.fct.2013.05.010>.
- ✓ Wittassek M, Heger W, Koch HM, Becker K, Angerer J and Kolossa-Gehring M, Daily intake of di(2-ethylhexyl) phthalate (DEHP) by German children – a comparison of two estimation models based on urinary DEHP metabolite levels. *Int J Hyg Environ Health* 210:35–42 (2007). <https://doi.org/10.1016/j.ijheh.2006.11.009>.
- ✓ Kim S, Kang S, Lee G, Lee S, Jo A, Kwak K et al., Urinary phthalate metabolites among elementary school children of Korea: sources, risks, and their association with oxidative stress marker. *Sci Total Environ* 472:49–55 (2014). <https://doi.org/10.1016/j.scitotenv.2013.10.118>.
- ✓ Lin S, Ku HY, Su PH, Chen JW, Huang PC, Angerer J et al., Phthalate exposure in pregnant women and their children in central Taiwan. *Chemosphere* 82:947–955 (2011). <https://doi.org/10.1016/j.chemosphere.2010.10.073>.
- ✓ Ait Bamai Y, Araki A, Kawai T, Tsuboi T, Yoshioka E, Kanazawa A et al., Comparisons of urinary phthalate metabolites and daily phthalate intakes among Japanese families. *Int J Hyg Environ Health* 218:461–470 (2015). <https://doi.org/10.1016/j.ijheh.2015.03.013>.
- ✓ Kavlock R, Barr D, Boekelheide K, Breslin W, Breysse P, Chapin R et al., NTP-CERHR Expert Panel update on the reproductive and developmental toxicity of di(2-ethylhexyl) phthalate. *Reprod Toxicol* 22:291–399 (2006).
- ✓ Jiang JT, Zhong C, Zhu YP, Xu DL, Wood K, Sun VL et al., Prenatal exposure to di-n-butyl phthalate (DBP) differentially alters androgen cascade in undeformed versus hypospadiac male rat offspring. *Reprod Toxicol* 61:75–81 (2016). <https://doi.org/10.1016/j.reprotox.2016.02.016>.
- ✓ Li M, Qiu L, Zhang Y, Hua Y, Tu S, He Y et al., Dose-related effect by maternal exposure to di-(2-ethylhexyl) phthalate plasticizer on inducing hypospadiac male rats. *Environ Toxicol Pharmacol* 35:55–60 (2013). <https://doi.org/10.1016/j.etap.2012.10.006>.
- ✓ Schlomer B, Breyer B, Copp H, Baskin L and DiSandro M, Do adult men with untreated hypospadias have adverse outcomes? A pilot study using a social media advertised survey. *J Pediatr Urol* 10:672–679 (2014). <https://doi.org/10.1016/j.jpurol.2014.01.024>.
- ✓ Ragab SM, Helwa MA and Khalaf AA, Serum cystatin C and microalbuminuria in children with immune thrombocytopenia under short course of corticosteroids. *Egypt Pediatr* 63:39–45 (2015).
- ✓ Tsai HJ, Chen BH, Wu CF, Wang SL, Huang PC, Tsai YC et al., Intake of phthalate-tainted foods and microalbuminuria in children: the 2011 Taiwan food scandal. *Environ Int* 89:129–137 (2016). <https://doi.org/10.1016/j.envint.2016.01.015>.
- ✓ Tomita I, Nakamura Y, Yagi Y and Tutikawa K, Fetotoxic effects of mono-2-ethylhexyl phthalate (MEHP) in mice. *Environ Health Perspect* 65:249–254 (1986).

THANKS!

Do you have any questions?
syedamaryam@uaar.edu.pk

