Oats Decoded: The lesser-known Nutritional Facts

Ms. Gayatri Dawda

Nutrition Executive

Marico Limited, India

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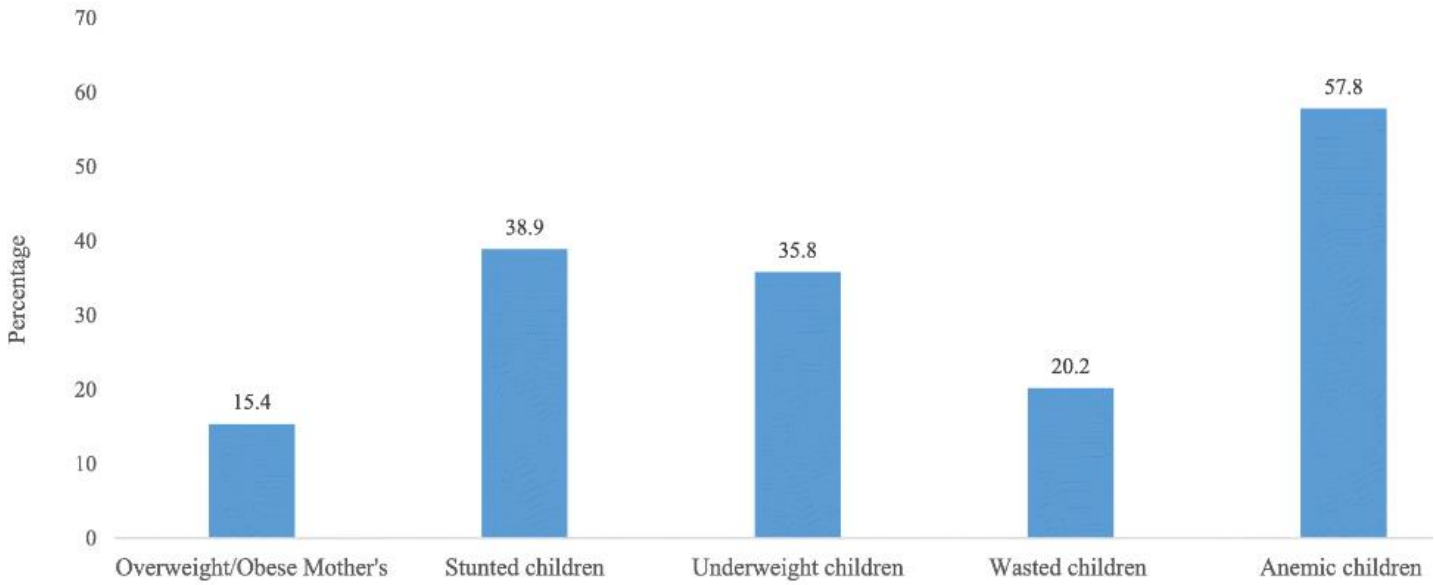
Transition from Undernutrition to Obesity

Health indicator	Change since NFHS 1
Infant mortality	↓
Stunting	↓
Anaemia	↑
Overweight/Obesity	↑
Hypertension	↑
Diabetes/Pre-diabetes	↑
Fertility rate	↓

Source: https://prsindia.org/

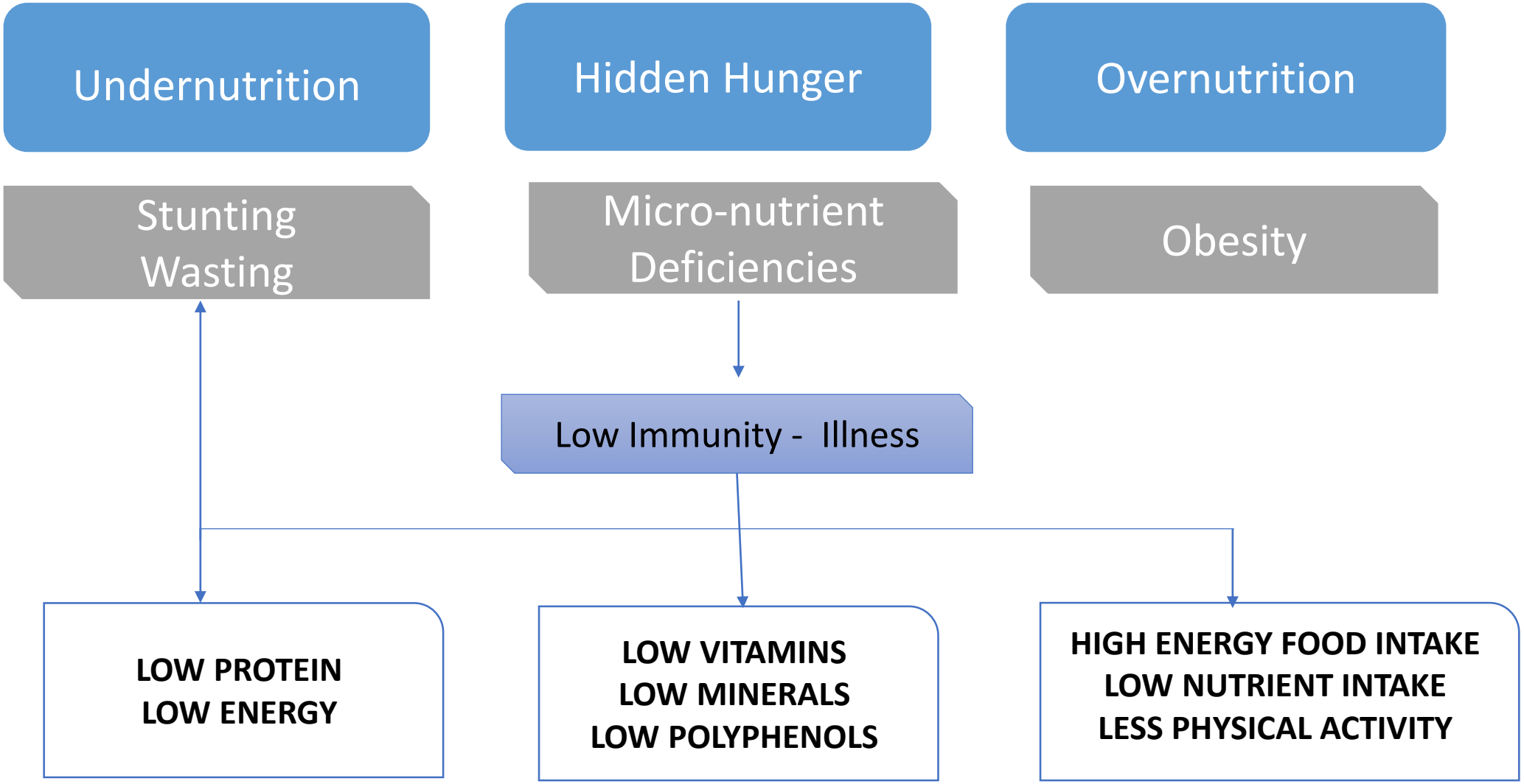
Triple Burden of Malnutrition In India (NFHS 4 to 5)



Source: Kumar p et al. Prevalence and factors associated with triple burden of malnutrition among mother-child pairs in India: a study based on National Family Health Survey 2015–16. BMC Public Health volume 21, Article number: 391 (2021)

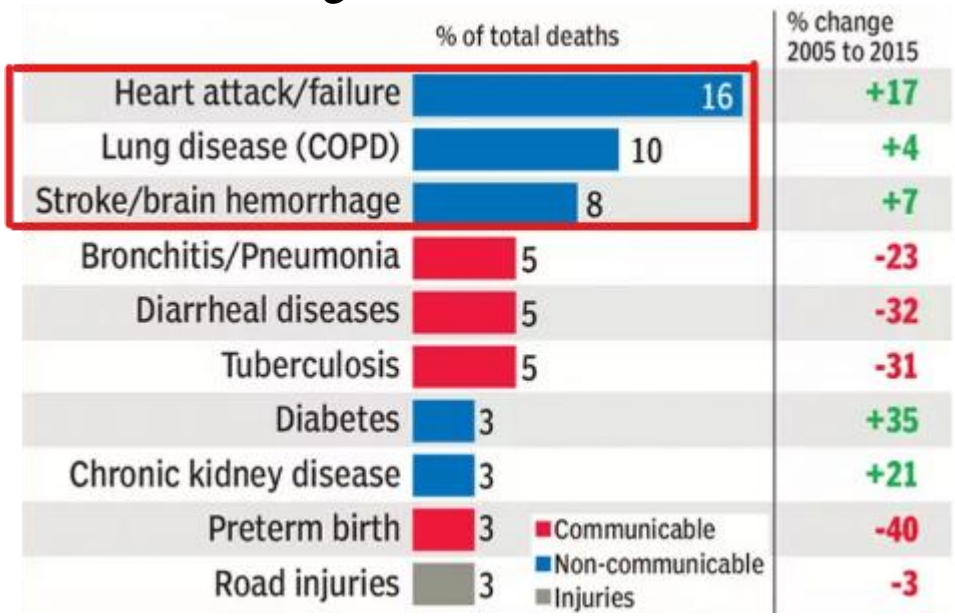
The triple burden of malnutrition (**Undernutrition, Obesity and Micronutrient deficiency**) is an increasingly recognized public health challenge – vastly increased in past 3 decades

The Triple Burden of Malnutrition



Alarming rise of NCDs in India : The Lancet Global Survey

- **Largest contributors to Mortality – CVDs (Ischemic heart disease)**
- **Contribution of CVDs increased 34.3% from 1990 to 2016**



Top 4 Reasons for CVDs

High Systolic BP

High Fasting Sugar

High BMI

Air Pollution

Top 3 causes of Mortality

1. **CVDs**
2. **Diabetes**
3. **Respiratory Diseases**

The Lancet Global Health Survey, 2018 & Khatri et al. A Review of Partial Least Squares Modeling (PLSM) for Water Quality Analysis, 2021

Nutrition Transition: towards diet linked with NCDs

Pattern 1 : Collecting Food – Varied diet, Robust, less nutritional deficiency, acute/infectious diseases, high mortality

Pattern 2 : Famine – Cereal predominant, Diet less varied, Labour intensive, High fertility, high maternal & child mortality, life expectancy was good

Pattern 3 : **Receding Famine** – More fruits, vegetables, animal produce, MCH issues, primitive clay oven industrialisation starts, mortality declines, population surge

Pattern 4 : Degenerative Diseases – More fat, more sugar, less fibre , obesity, elderly issues, NCD, fewer jobs, less physical activity, Rapid income growth, life expectancy increases

Pattern 5 : Behavioural Change – High quality fats, less refined carb, more wholegrains, reduction in body fat, improve bone health, decrease in anaemia, disability free, life expectancy above 80yr

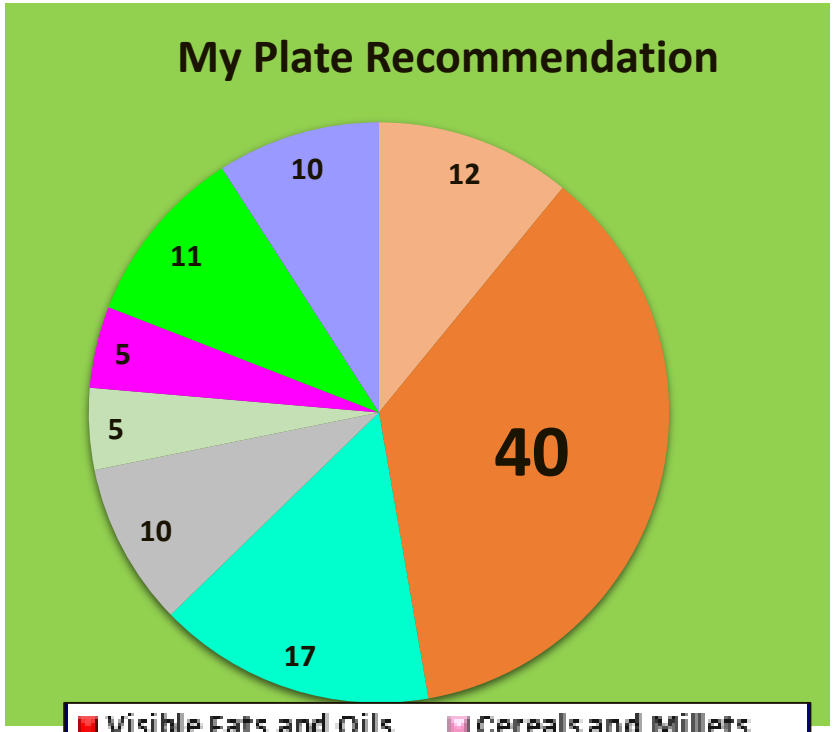
Positive Role Models at National Level

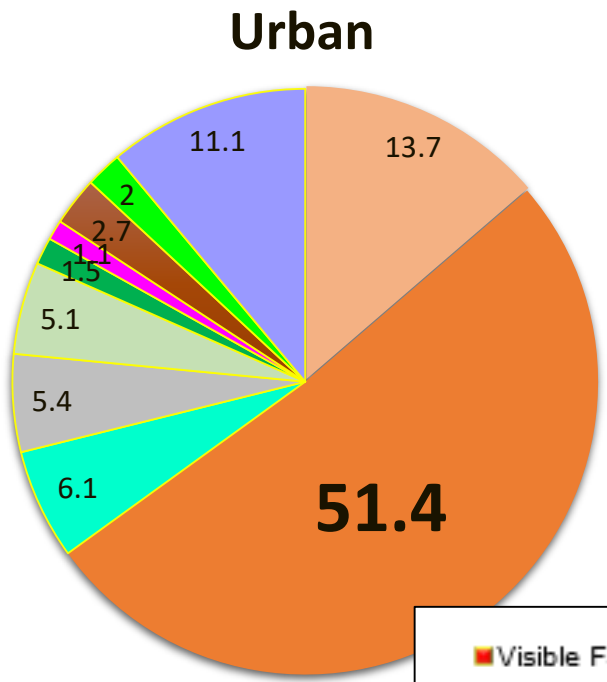
Countries to make reforms in policies to achieve reduction in Nutrition related NCD's

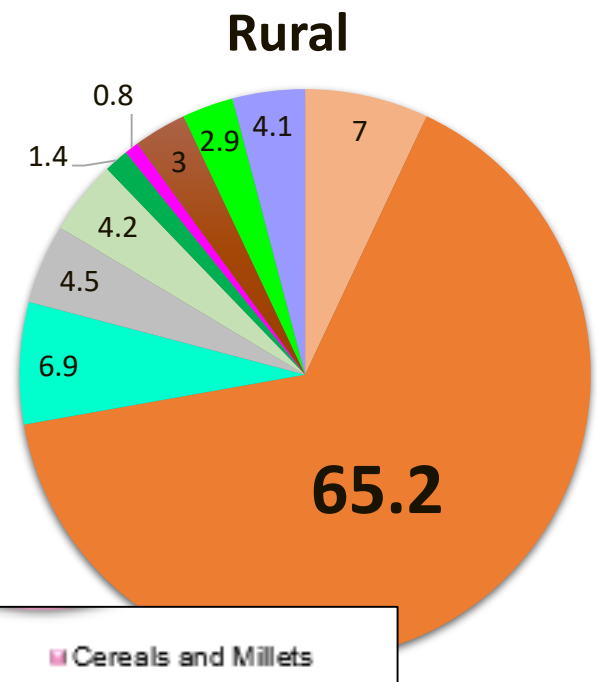
- **FINLAND –** National price policy, Food labelling reforms & Nutrition education
- **BRAZIL** – Decrease in obesity in women with legislative policy changes & National School Feeding programme
- **SOUTH KOREA –** Encourage traditional diet – low in fat & high in vegetables

Source : Barry Popkin. Global nutrition dynamics: the world is shifting rapidly toward a diet linked with noncommunicable diseases. August 2006. AJCN 84(2):289-298

What is India eating?







- **Higher intake of simple carbs from refined cereals**
- **Lower Intake of Positive Nutrients – poses a higher risk**

Source: What India Eats, ICMR – National Institute of Nutrition (2021)
Others includes chips, biscuit, chocolates, sweets and juices

Oats: A unique Wholegrain

ICMR – NIN recommends at least 50% Cereals & Millets to be Wholegrains

Globally, Wheat, Rice & Corn accounts for >60% calories consumed

According to World Wholegrain Council, **Oats almost never have their bran and germ removed in** processing. Because they are tightly bound Hence, Oats are always consumed as 'Wholegrains'

Source : Gulvady A et al. Nutritional Comparison of Oats and Other Commonly Consumed Whole Grains. Oats Nutrition and Technology, First Edition. 2014

Dietary Fiber in Oats vs Other Cereals

Quantity of Dietary Fiber

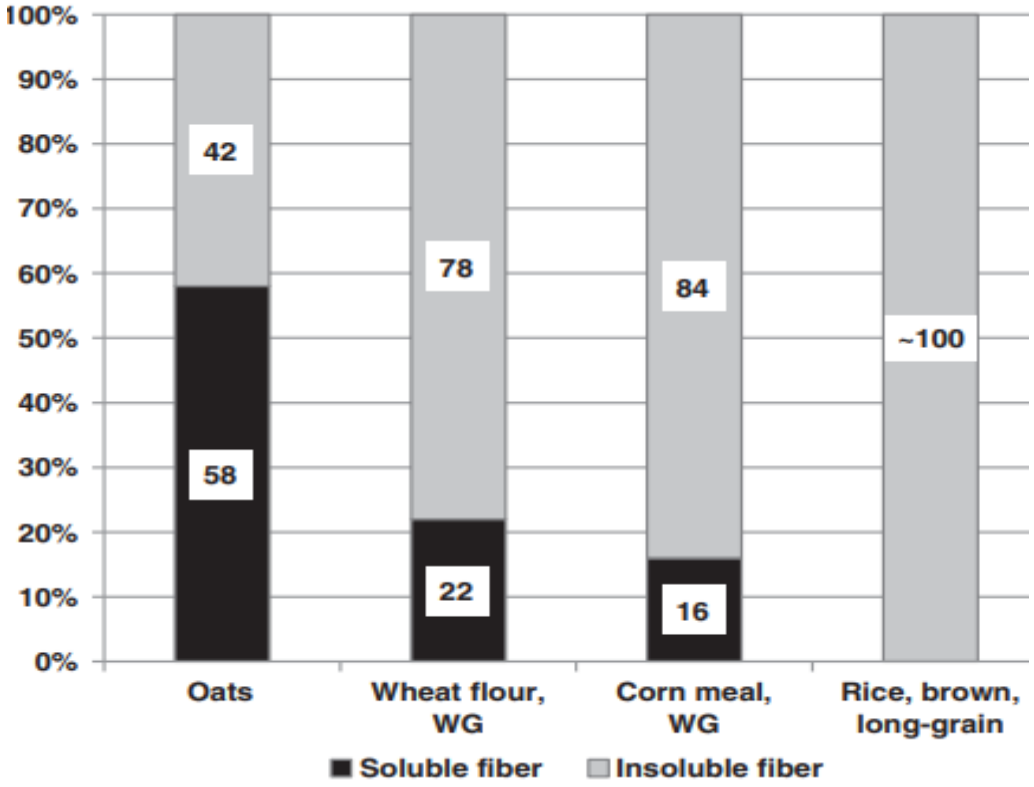
Macronutrient Comparison of Cereal grains

Nutrient \ Grain	Oats, dry	Wheat flour, WG	Corn meal, WG	Rice, white, long grain, raw, unenriched	Rice, brown, long grain, raw, unenriched
Fiber (g)	11	11	7	1	4
Protein (g)	17	13	8	7	8
Lipid (g)	7	3	4	1	3

Beta glucan is a type of soluble fiber found naturally found in oats, which is clinically proven to lower cholesterol levels when consumed at levels of 3g/d with diet low in saturated fat

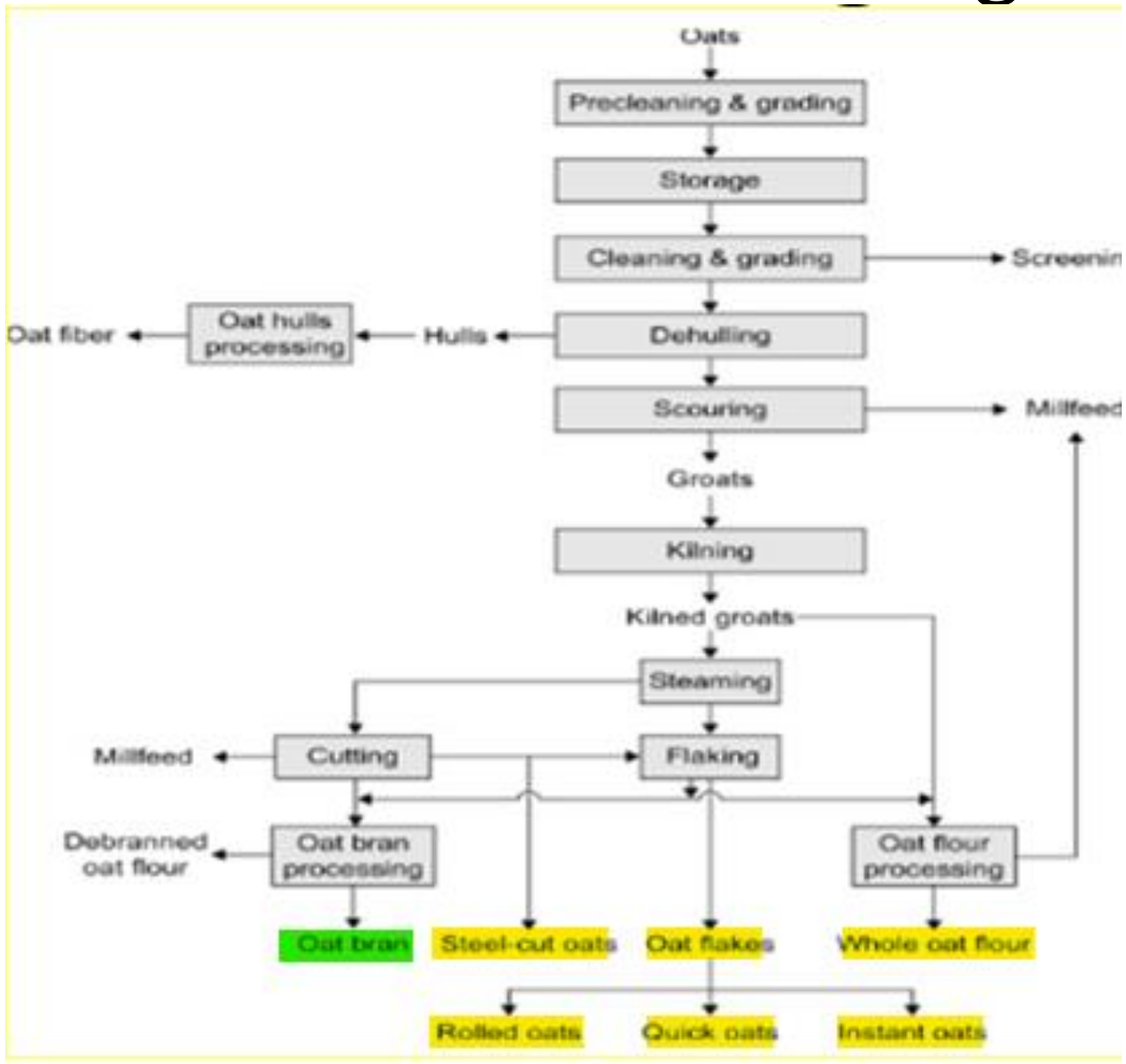
Quality of Dietary Fiber

% of Soluble/Insoluble Fiber in Cereals



Source : Gulvady A et al. Nutritional Comparison of Oats and Other Commonly Consumed Whole Grains. Oats Nutrition and Technology. First Edition. 2014 & EFSA.2010)

Processing of Oats



Oat bran production is a specialized method involving **grinding oat groats** and **separating** the resulting oat flour by **sieving, bolting** and/or other suitable means into fractions containing Oat bran

All other forms of Oats – Steel cut oats, Oat flakes, Rolled Oats, Oat flour, Instant Oats **are Wholegrains with Bran Intact**

Source : Ravi Menon et al. Oats—From Farm to Fork. Advances in Food & Nutrition Research. Vol 77, 2016, Pages 1-55 & Guo M et al. DIETARY FIBER AND DIETARY FIBER RICH FOODS. Functional Foods:

Characteristics of Wholegrain Oats

	Whole Oat Groats	Steel Cut Oats / Irish Oats	Rolled Oats	Quick Cooking/ Instant Oats	Oat Flour
Processing Technique	Minimal	Whole Oat groats are cut in 2-4 pcs with steel blade	Oat groat is steamed , then rolled between steel rollers	Steamed & Rolled thinner than rolled oats. Also, cut into small pcs.	Groats or Flakes are ground using hammer mill & air is passed through the flour to reduce clumping
Texture & Flavour	Texture like rice & Nutty flavour	Chewy	Thick grain is chewy	Smooth/Creamy/mushy texture	Silkier as compared to wheat flour. Has Nutty taste
Cooking Time	30 to 45 minutes	20 to 30 minutes	Appx 10 minutes	1 to 3 minutes	Depends on the recipe
Applications	Risotto or Grain based salad	Overnight Oats or Granola	Versatile form – Porridge, granola, muesli, smoothies	Porridge, smoothies, pancakes	Baby foods, RTE snacks, Dairy beverages, RTC Soups, Snack bars

Source : Martillaa M. S. et al. Functional Foods: Principles and Technology, 2009. Flavour & texture in Processing of New Oat Foods

Oat Nutrients

OAT STARCH & D.FIBER

Lower Digestible Carbs than Other Cereals (55-60%)

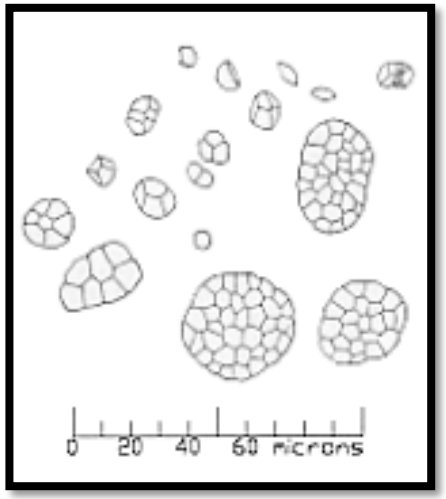
Constitutes 60% of Oat Grain (majorly in Endosperm)

Oats contain significant amount of **Resistant starch (25%)**

Approx **7 % RDS & 22 % SDS**

Different than other cereals - small size of granules, **higher swelling factor** and **high lipid content, resistant to amylase , high amylose**

Oats contain higher B-Glucan than Whole wheat (69%), Corn (23%) & Brown rice (100%)



Oat Starch (*Amylum Avenae*)

Single granules and agglomerates.

Granules up to 65 microns

Recommended Intake of **20-30g RS is** required for benefit. However, only **3-8g/d is consumed** . Most foods have **RS<3%**. Oats has **25% starch as RS.** Oat consumption can help bridge gap.

Resistant Starch – Is a Functional Fiber (SCFA production)

Source : Rasane P et al. Nutritional advantages of oats and opportunities for its processing as value added foods - a review. J Food Sci Technol. 2015 Feb; 52(2): 662–675.

Oat Nutrients

OAT PROTEIN (1/2)

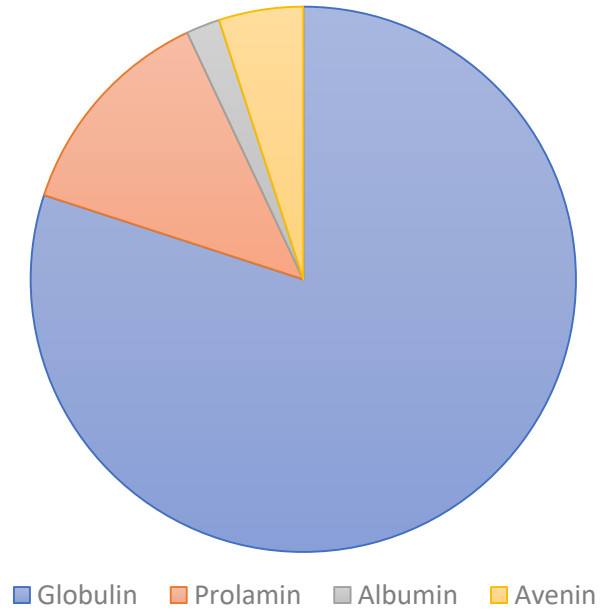
The protein content in oats ranges from **12.4-24.5%**

Protein Efficiency Ratio (PER) of Oat protein is 1.8, whereas that of wheat is 0.8

- **Rich in Globulins 50-80%**– contain basic amino acids (lysine, histidine, and arginine)
- **High globulin: prolamin** ratio of oats is better than other cereals

Prolamins form **10%-20% of the total protein in oats,** compared to 40%-50% of the total protein in wheat

Prolamins exhibit a lower Lysine content compared to albumins and globulins



Source : Rasane P et al. Nutritional advantages of oats and opportunities for its processing as value added foods - a review. J Food Sci Technol. 2015 Feb; 52(2): 662–675.

Oat Nutrients

OAT PROTEIN (2/2)

Amino acid profiles of cereals presented in g/100g of cereals

Amino acid (g/100g)	Barley	Maize	Oat	Rice	Rye	Wheat
Threonine	0.33	0.35	0.42	0.72	0.73	0.7
Valine	0.44	0.43	0.61	0.39	0.45	0.5
Methionine	0.16	0.24	0.28	0.21	0.15	0.19
Isoleucine	0.31	0.3	0.45	0.34	0.35	0.5
Leucine	0.72	0.92	0.94	0.66	0.67	0.82
Phenyl Alanine	0.52	0.46	0.65	0.42	0.46	0.6
Histidine	0.23	0.22	0.33	0.16	0.24	0.25
Lysine	0.33	0.29	0.44	0.23	0.34	0.36
TEAA	3.04	3.21	4.12	2.68	2.98	3.73
TNEAA	6.9	5.29	7.4	4.7	6	7.6
TAA	9.94	8.5	11.52	7.4	9	11.4

- Oats contain Higher Lysine, Methionine which is **Limiting** in Cereals & Pulses
- Leucine – role in **Muscle Protein Synthesis**
- Methionine –role in **Innate Immunity**
- Lysine : imp for Carnitine production, converts food to energy & **lowers Cholesterol**
- Higher TEAA than most cereals

Source : Rasane P et al. Nutritional advantages of oats and opportunities for its processing as value added foods - a review. J Food Sci Technol. 2015 Feb; 52(2): 662–675.

Oat Nutrients

OAT LIPIDS

Higher Fats 5-9% than most cereals

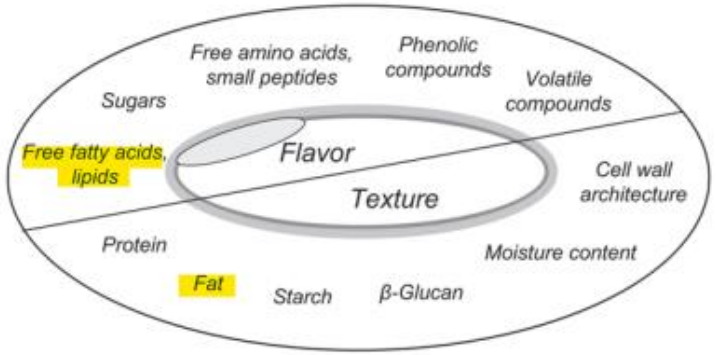
Contained in Endosperm

80-83% Unsaturated FA's

PUFA - 40-43%, while MUFA - 36-39%. Saturated fat - Appx 20-22%.

Covers the starch granules & slows digestion

Helps Lowering GI



Oat Lipids give a characteristic Nutty Flavour to Oats.

Fatty Acid \ Grain	Oats	Wheat flour WG	Corn meal WG	Brown rice
Polyunsaturated fat (%)	42	63	53	37
Monounsaturated fat (%)	37	16	30	41
Saturated fat (%)	20	21	17	22

Oats present a Balanced Fatty Acid Profile

Source :Rasane P et al. Nutritional advantages of oats and opportunities for its processing as value added foods - a review. J Food Sci Technol. 2015 Feb; 52(2): 662–675. & Gulvady, A. A., Brown, R. C., & Bell, J. A. (2013). Nutritional Comparison of Oats and Other Commonly Consumed Whole Grains. Oats Nutrition and Technology, 71–93.

Oat Nutrients

OAT POLYPHENOLS

High AO potential attributed to the presence of AVAs, Phenolic compounds, Vitamin E, sterols and Phytic acid

Avenanthramides (AVAs) are exclusive to oat grains

High in AVAs : 30-289mg/kg

AVA-C, one of the three major AVA, 1/3rd of the total of AVAs in oat grain & has the highest antioxidant capacity.

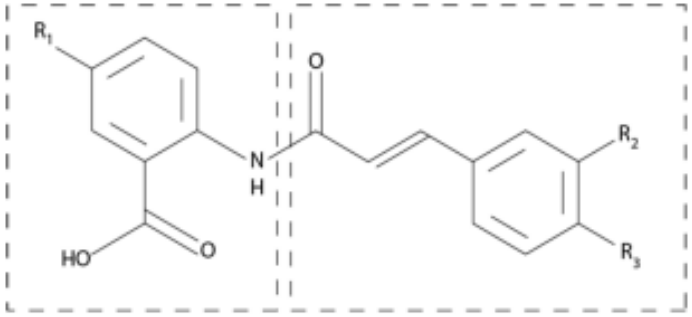
Bioavailability – tested in humans

AVAs possess AO activity 10-30 times than phenolic acids present in cereals

Highest AO activity AVA-C >AVA-B > AVA-A

- In a randomised, placebo-controlled trial by Chen et al, **plasma concentrations of AVA** increased in humans after administering Oats enriched with **0.5 & 1g AVA**.
- Oats intake increased plasma **Glutathione** levels too

Chemical Structure



Anthranilic acid Cinnamic adic

Compound	R_1	R_2	R_3	Anthranilic acid	Cinnamic adic
AVA-A	OH	H	OH	5-hydroxyanthranilic acid	*p*-coumaric acid
AVA-B	OH	OCH_3	OH	5-hydroxyanthranilic acid	ferrulic acid
AVA-C	OH	OH	OH	5-hydroxyanthranilic acid	caffeic acid

Source: Boz H. Phenolic Amides (Avenanthramides) in Oats – A review. Czech J. Food Sci., 33, 2015 (5): 399–404

Oat Nutrients

MINERALS IN OATS

Mineral content per 100 g grains

Mineral (mg) \ Grain	Oats, dry	Wheat flour, WG	Corn meal, WG	Rice, white, long grain, raw, unenriched	Rice, brown, long grain, raw, unenriched
Calcium	54	34	6	28	23
Iron	4.72	3.6	3.45	0.8	1.47
Magnesium	177	137	127	25	143
Phosphorus	523	357	241	115	333
Potassium	429	363	287	115	223
Sodium	2	2	35	5	7
Zinc	3.97	2.6	1.82	1.09	2.02
Copper	0.626	0.41	0.193	0.22	0.277
Manganese	4.916	4.067	0.498	1.088	3.743

Source : USDA Nutrition Database

% DV with 100g Oats:

- Calcium 5.4%
- Magnesium – 40%
- Iron – 25%
- Copper - 35%
- Manganese – 100%

Minerals	Function
Iron	Hb production
Copper	RBC & Bone Health
Calcium	Bone & Teeth Health, Nerve conduction
Magnesium	Enzyme activation, Nerve conduction
Manganese	Bone & Tissue Health
Zinc	Homeostasis & Enzyme Co-factor

Source:Gulvady, A. et al. (2013). Nutritional Comparison of Oats and Other Commonly Consumed Whole Grains. Oats Nutrition and Technology, 71–93.

Impact on Health other than Lowering Cholesterol

Oat Nutrients

Antioxidant action

Ryan et al. (2011) discovered that most Oat brands exhibit antioxidant activity in the range of 1500-1800 ug/g GAE, attributed to the presence of AVAs, minerals, Sterols, Phytic acid, and Vitamin E .

Anti-inflammatory action

Kim et al. (2021) conducted a meta-analysis revealing a notable decrease in CRP levels and reduced IL-6 levels in dyslipidemic subjects following Oat consumption. This effect was attributed to the presence of AVAs and Oat β-Glucan.

•Vasodilation

•A meta-analysis of 21 RCTs by Xi et al, 2023 revealed, that Oat consumption is effective in reducing systolic BP levels, particularly in individuals whose baseline BP is in the hypertensive range when compared with control group participants consuming refined grains.(OBG >5g/d for >8weeks)

Anti-allergy

AVAs share a structural resemblance with 'Transilast,' an anti-allergy medicine. DHAvn, a synthetic derivative of Oat AVAs, exhibits anti-histamine effects and is employed in treating skin disorders like itching, redness, and wheals.

Source: Kim S et al. Effects of Oats (Avena sativa L.) on Inflammation: A Systematic Review and Meta-Analysis of Randomized Controlled Trials. Front Nutr. 2021; 8: 722866, Ryan L. et al. Oat-based breakfast cereals are a rich source of polyphenols and high in antioxidant potential. Journal of Food Composition and Analysis 24 (2011) 929–934, Xi et al. Effect of Oat Consumption on Blood Pressure: A Systematic Review and Meta-Analysis of Randomized Controlled TrialsVOLUME 123, ISSUE 5, P809-823, MAY 2023

Summary: Impact of Oats Intake on Various Physiological Parameters of Metabolic Syndrome

- ✓Suppresses glucose surge post consumption
- ✓Increases satiety
- ✓Reduces body weight and body fat
- ✓Improves blood pressure
- ✓Reduces Total cholesterol and LDL-C
- ✓Has lower Glycaemic Variability
- ✓Has increased Anti-inflammatory and Anti-atherogenic potential
- ✓Store-house of Vitamins, Minerals & Anti-oxidants

A Food Solution to Potentially Help Manage NCD's

Thank You!