Cross Cultural Perception of Whole & Skim Milk Powders

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- Background
- CROSS CULTURAL SENSORY PROJECT
 - The work presented is part of a larger project that is funded by Teagasc and has partners in Ireland, the USA and China
 - Dr Maurice O'Sullivan will also cover this area in the next presentation



 A team of sensory and flavour chemistry experts at each location





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China-Ireland International Cooperation Centre for Food Material Science and Structure Design (FMSD)





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中国-爱尔兰国际合作 食品物质学与结构设计研究中心

China-Ireland International Cooperation Centre for Food Material Science and Structure Design



• New sensory laboratory in Fujiang University in 2016







Mr Zeng Cheng PhD Student





- A substantial market opportunity exists for Irish dairy products in Asia, but also in North America.
- However knowledge of differences in cross-cultural flavour perception of (Irish) dairy products is vital in order to increase market share, especially among identified growth areas, such as North America and Asia.
- There are also potential issues around sensory perception of Irish dairy products in both China and North America with terms such as "Oceanic" and "Barnyard" often used









- Develop separate hedonic assessment, which will involve consumer liking evaluation and perception
 - Defined ballots with excess 100 consumers
- Understand factors behind "Oceanic" and "Barnyard" flavour of Irish dairy products
- Set up descriptive panels in each country to evaluate selected dairy products
- Create defined cross cultural sensory language
 - Product specific
- Share expertise in flavour chemistry



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- Linked to Profiling Milk from Grass project
- Sensorial and volatile properties of milk produced from 54 Friesian cows on three separate diets
- Volatile profiles of the individual forage samples was also undertaken to determine if any direct transfer of volatile compounds from forage to milk and subsequent Cheddar cheese, butter, whole milk powder and skim milk powder

Grass-only

Grass-Clover

TMR

Perennial ryegrass Perennial ryegrass with White Grass silage, maize

clover : Trifolium repenes L. silage, soya, molasses,











—SL —MD

- Milk
- Sensory Analysis
 - Hedonics/Acceptance
 - Ranked Descriptive Analysis
- Flavour chemistry
 - Identify the volatile compounds by GCMS
 - Untargeted Approach
 - HS-SPME, TD & SE
 - Single Quad MS Scan
 - GCxGC TOFMS







AGRICULTURE AND FOOD DEVELOPMENT AUTHORITY



- β-carotene
 - β-carotene levels (mg/kg) in milk were in the order of grass (0.34), grass/clover (0.26) and TMR (0.13) on average over the season (2015).
 - β-carotene levels impacted on milk color in terms of b* value and sensory analysis (P<0.05). ----
 - Grass b* (16.057)
 - Grass/clover b* (15.852)
 - TMR b* (9.68)



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The Irish Agriculture and Food Development Authority



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- β-carotene Metabolism
 - β-carotene is degraded by rumen bacteria to a number of volatile compounds, one of the most abundant is **Toluene**
 - The abundance of toluene corresponds to the concentration of β -carotene in milk, also noted for Butter and Cheddar +
 - Both β -carotene and toluene are potential biomarkers for some pasture based dairy products
 - Neither are exclusively present in pasture derived dairy products, but are present at higher concentrations
 - We did not find any correlation between sensory characteristics and toluene concentration in milk, cheese or butter
 - Toluene has a high odour threshold





- Phenolic Compound p-Cresol
 - We found a direct correlation between abundance and diet
 - Clover>Grass>TMR
 - Barnyard aroma was highest in clover milks (P<0.05)
- Sensory correlation
 - **P-cresol** is characterized as having a *barnyard* or *cowy* aroma and abundance correlated with sensory attribute







- p-Cresol
 - Abundance of p-cresol in these milks was low
 - High odor activity
 - Did not correspond with β -carotene levels
 - More digestible protein content of grass and grass/clover than TMR may also be a contributing factor
 - Likely metabolism of isoflavone (formonenetin) in the rumen is a factor high content in clover
 - P-cresol is a potential biomarker for pasture derived dairy products
 - Direct correlation of p-cresol abundance in milk and with sensory perception of *barny*, *cowy* attributes











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Effect of different forage types on the volatile and sensory properties of bovine milk

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Review

Factors Influencing the Flavour of Bovine Milk and Cheese from Grass Based versus Non-Grass Based Milk Production Systems

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- Started with this product because it was the easy to ship samples to the USA and China
- Consumer studies
 - On-line system with >100 consumers in Ireland (UCC), USA (NCSC) and China (Fujiang)
 - WMP & SMP produced from cows on the different diets (Grass, Grass/Clover & TMR)
 - Define the cultural differences (if they exist), & try to identify chemicals responsible and source
 - Difficulties (storage stability of the WMP)



Now please taste sample _____ and answer the following questions:

Which statement best describes your impression of the **OVERALL LIKING** of this product?

Dislike Dislike	Dislike	Dislike	Neither Like nor	Like	Like	Like Very	Like
Extremely Very Much	Moderately	Slightly	Dislike	Slightly	Moderately	Much	Extremely

Which statement best describes your impression of the FLAVOR of this product?

Nei	ther
Dislike Dislike Dislike Dislike Likk	s nor Like Like Like Very Like
Extremely Very Much Moderately Slightly Dis	like Slightly Moderately Much Extremely

Which statement best describes your impression of the FRESHNESS of this product?

Not At All Fresh Extremely Fresh Extremely Fresh

Which statement best describes your impression of the **COOKED FLAVOR** of this product?



Which statement best describes your impression of the **MOUTHFEEL/THICKNESS** of this product?









- Flavour Chemistry Results SMP ONLY
 - PLSR Biplot







	Abundance				
Volatile Compound	GRASS	CLOVER	TMR	P value	Odour Description
Heptanal	1.63E+04	2.06E+04	1.25E+04	0.001	Slightly fruity, fatty, oily, green, woody
Pentanal	1.63E+04	1.10E+04	6.51E+03	0.006	Pungent, almond-like, chemical, malty, apple, green
Dimethyl sulfone	1.81E+05	2.07E+05	1.23E+05	0.034	Sulfurous, hot milk, burnt
Acetoin	3.54E+03	1.84E+03	9.00E+03	0.002	Buttery, sour milk,caramel
1-Hydroxy-2-propanone	2.17E+04	2.17E+04	4.07E+04	0.018	Pungent, sweet, carmellic, etheral
Acetic acid	7.55E+04	4.47E+04	9.07E+04	0.002	Vinegar, peppers, green, fruity floral, sour
Propanoic acid	1.59E+04	9.35E+03	1.60E+04	0.190	Pungent, sour milk, cheese, gas, burnt, cloves, fruity
Ethanol	7.68E+04	9.12E+04	8.27E+04	0.025	Dry dust, alcohol

• Key Volatiles

- Aldehydes (Heptanal & pentanal) from lipid oxidation
- Sulphur (Dimethyl sulfone) from amino acid metabolism
- Others (Acetoin, 1-hydroxy-2-propanone, acetic acid, propionic acid & ethanol) mainly from carbohydrate metabolism



SMP – Irish Consumers

- Clover and Grass scored significantly higher in "Overall Liking", "Flavour Liking", "Freshness" and "Quality".
- TMR scored significantly higher in "Appearance Liking", "Cooked Flavour"

Table 1. Summary of Consumer Acceptance Scores for Rehydrated Skim Milk

 Powders

		Cloverfed	Grassfed	Total Mixed Ration	
Appearance Liking		5.5b	5.4b	5.9a	
Aroma Likir	ıg	5.4a	5.7a	5.4a	
Overall Likir	ng	5.3a	5.1a	4.4b	
Flavor Likin	Ig	5.1a	5.1a	4.4b	
Freshness	;	2.9a	3.0a	2.5b	
Cooked Flavor		2.7b	2.7b	3.1a	
Mouthfeel/Thickness Liking		5.4a	5.6a	5.1a	
Creaminess Liking		5.4a	4.9a	4.7a	
Aftertaste	Yes	5%b	100%a	100%a	
	No	95%a	0%b	0%b	
Aftertaste Liking*		4.1a(n=3)	4.1a(n=53)	3.6a(n=53)	
Aftertaste Intensity*		2.9b(n=3)	2.6b(n=53)	3.1ab(n=53)	
Quality		3.1a	3a	2.8b	







SMP – USA Consumers

• TMR samples were scored significantly higher in "Appearance Liking", "Overall Liking", "Flavour Liking" and "Quality".

		Cloverfed	Grassfed	Total Mixed Ration
Appearance Liking		6.2b	6.2b	6.9a
Aroma Likir	ng	5.6a	5.6a	6.0a
Overall Liki	ng	5.4b 5.7ab		6.0a
Flavor Likir	ng	5.3b	5.4ab	5.8a
Freshness	ò	3.2a	3.2a	3.4a
Cooked Flavor		2.8a	2.7a	2.8a
Mouthfeel/Thickness Liking		6.0a	5.9a	6.2a
Creaminess Liking		5.6a	5.6a	5.9a
Aftertaste	Yes	60.4%a	56.4%a	56.4%a
	No	39.6%a	43.6%a	43.6%a
Aftertaste Liking*		4.3a (n=61)	4.0a (n=57)	4.6a (n=57)
Aftertaste Intensity*		3.0a (n=61)	3.1a (n=57)	2.8a (n=57)
Quality		3.0b	3.1ab	3.3a

 Table 1. Summary of Consumer Acceptance Scores for Rehydrated Skim Milk

 Powders









SMP – Chinese Consumers

- Grass samples scored significantly highest for "Quality"
- TMR & Grass samples were scored significantly higher in "Off-flavour"

Table 1. Summary of Consumer Acceptance Scores for Rehydrated Skim Milk Powders

		Cloverfed	Grassfed	Total Mixed Ration
Appearance Liking		5.8a	5.8a	5.8a
Aroma Likir	ng	5.4a	5.5a	5.6a
Overall Likir	ng	5.5a	5.6a	5.6a
Flavor Likir	ig	5.5a	5.5a	5.4a
Freshness	5	3.0a	3.0a	3.0a
Cooked Flavor		2.5a	2.5a	2.7a
Off-flavour		1.3b	1.4a	1.6a
Mouthfeel/Thickness Liking		5.3a	5.4a	5.3a
Creaminess Liking		5.2a	5.3a	5.2a
Aftertaste	Yes	74%a	73.1%a	71.2%a
	No	26%a	26.9%a	28.8%a
Aftertaste Liking*		5.2a(n=157)	5.5a(n=155)	5.4a(n=151)
Quality		3.1b(n=55)	3.3a(n=57)	3.2b(n=61)







CONCLUSION

- Bovine diet influences the sensory perception of dairy products
- Bovine diet influences the volatile profile
 - Directly and indirectly
- Sensory Impact varies according to the product
 - Fat content important
- Cross cultural differences in sensory perception exist for dairy products
 - Various reasons
- A lot more work to do

