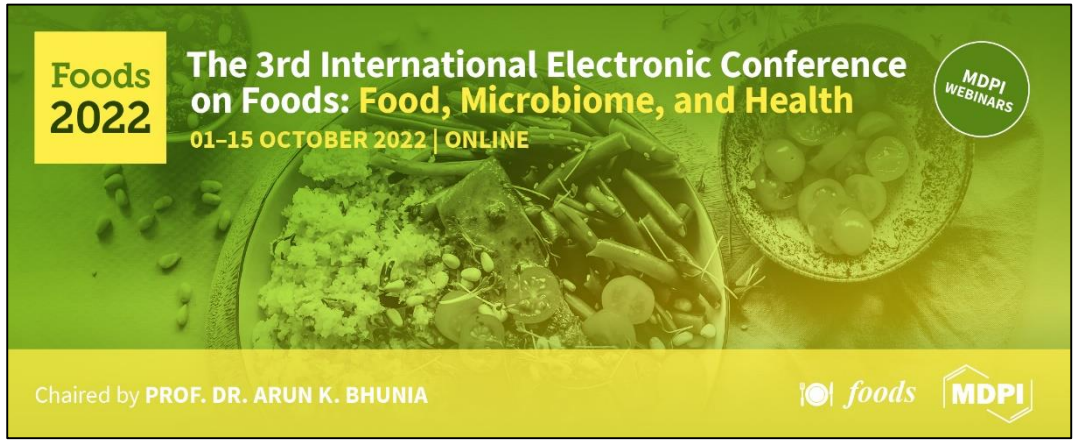
EFFECTS OF PARTIALLY SUBSTITUTING WHEAT FLOUR WITH TIGER NUT FLOUR ON THE PHYSICAL AND SENSORY PROPERTIES OF DIFFERENT TYPES OF BREAD

Joshua Akanson[1], Nazir Kizzie-Hayford[2], Jerry Ampofo-Asiama[2], Ernest Ekow Abano[1]

Department of Agricultural Engineering[1], Department of Biochemistry[2], College of Agriculture and Natural Sciences

University of Cape Coast, Cape Coast, Ghana.



1-15/10/2022

Background

- Tiger nut, a tuberous rhizome is a rich source of nutrients, phytochemicals, vitamins C and E
- Grows in temperate and tropical regions, especially in Ghana and several West African countries
- Investigated for use as vegetable milk, yoghurt, vegetable oils, biscuit, pasta egg tagliatelle, extruded products, bread etc.



Background

- Use for bread, a world-wide staple, could improve tiger nut utilization for food whilst enhancing properties of some types of bread (Oke at al. 2019)
- Several types of bread form a major staple in Ghana but
- Currently wheat flour is limited, affecting cost and access to bread in Ghana
- Partial substitution of wheat flour with tiger nut flour could be relevant



Aim of study

- To determine the effects of partially substituting wheat flour with tiger nut flour on the physicochemical and sensory properties of different types of bread

Research questions

1. What is the acceptable levels for partially substituting wheat flour with tiger nut flour in different bread types?
2. How does the substitution influence the physical and nutritional properties?
3. How does the substituting affect the sensory properties and consumer acceptability?



EXPERIMENTAL OUTLINE

Tiger nut

Drying (70 °C, 13hr)

Milling

Tiger nut flour

0 %
10 %
15 %
20 %
25 %
30 %

Tiger nut flour

Analyses:

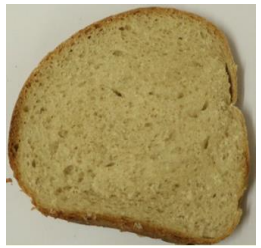
Physical	Sensory	Nutrient
Browning	Colour	Protein
Crust lightness	Aroma	Fat
Specific volume	Mouthfeel	Fiber
Firmness	Aftertaste	Ash
	Acceptability	Carbohydrate

Ingredients (g)	Tea Bread	Sugar bread	Butter bread
Flour	1250	1250	1250
Margarine	144	144	288
Salt	9	6	9
Sugar	68	214.5	68
Yeast	0.6	0.6	0.6
Nutmeg	3	3	3
Water (mL)	650	650	650

Results: Effects on physical properties of butter, tea and sugar breads

Wheat flour (WF) substituted with various amounts of tiger nut flour (WF:TNF) in Sugar bread


100:0


90:10

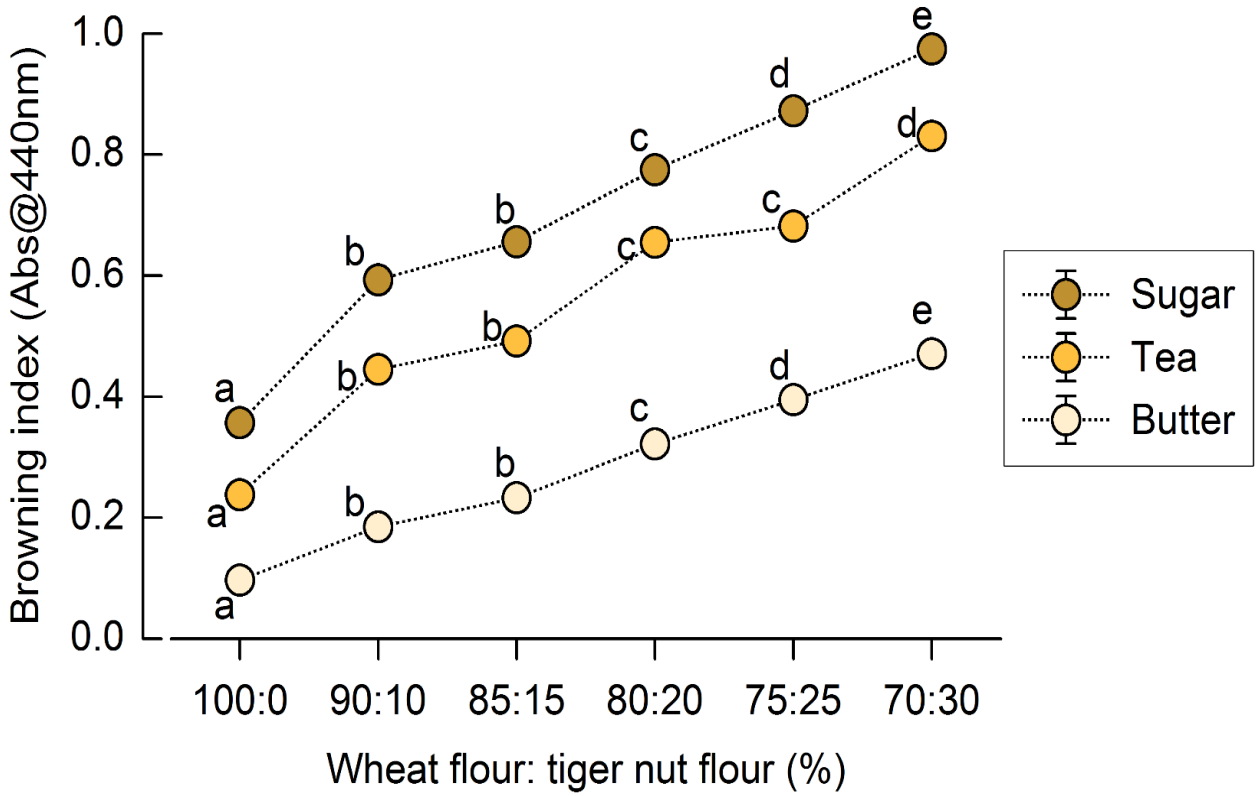

85:15


80:20


75:25


70:30

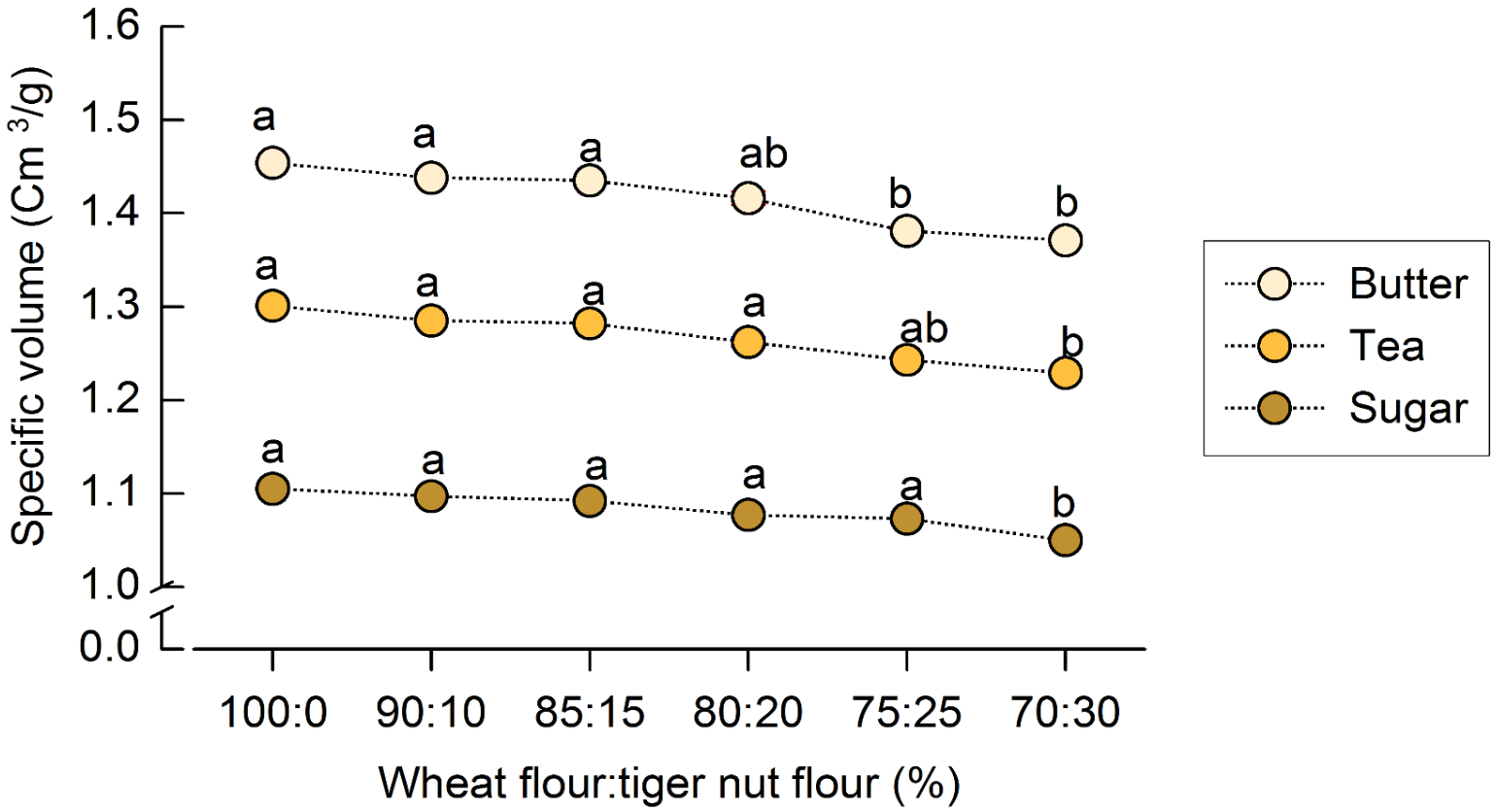
Browning index



Results: Physical properties of butter, tea and sugar breads

- Butter bread showed the highest specific volume
- Partial substitution with TNF decreased the specific volume
- Effects of substitution levels on specific volume depends on the type of bread

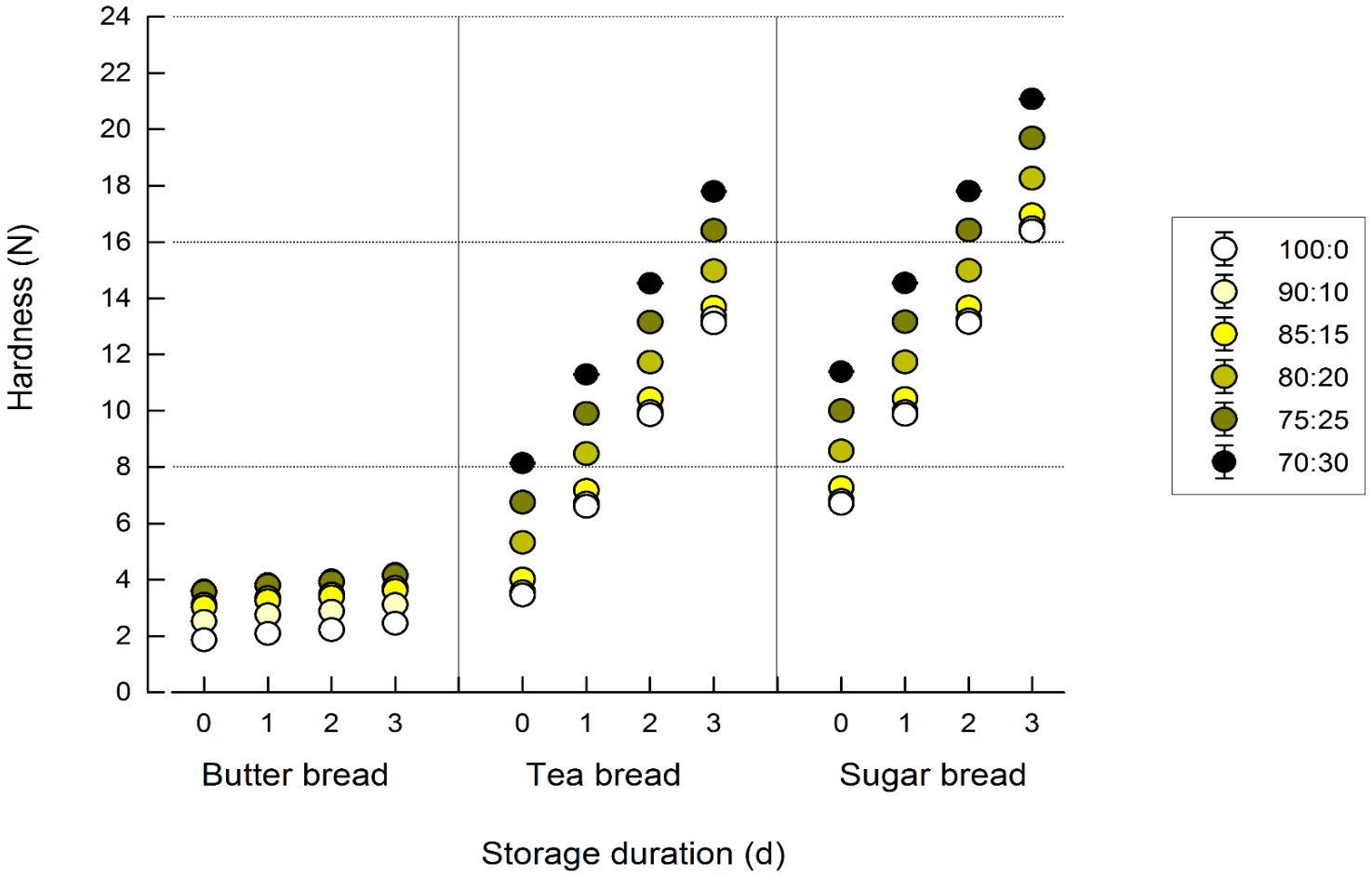
Specific volume



Results: Physical properties of butter, tea and sugar breads

- Crumb firmness: Sugar bread (S_b) > Tea bread (T_b) >Butter bread (B_b)
- Storage significantly increased firmness of S_b & T_b but not B_b
- Effects of TNF on firmness insignificant for B_b

Crumb firmness during 3 d storage



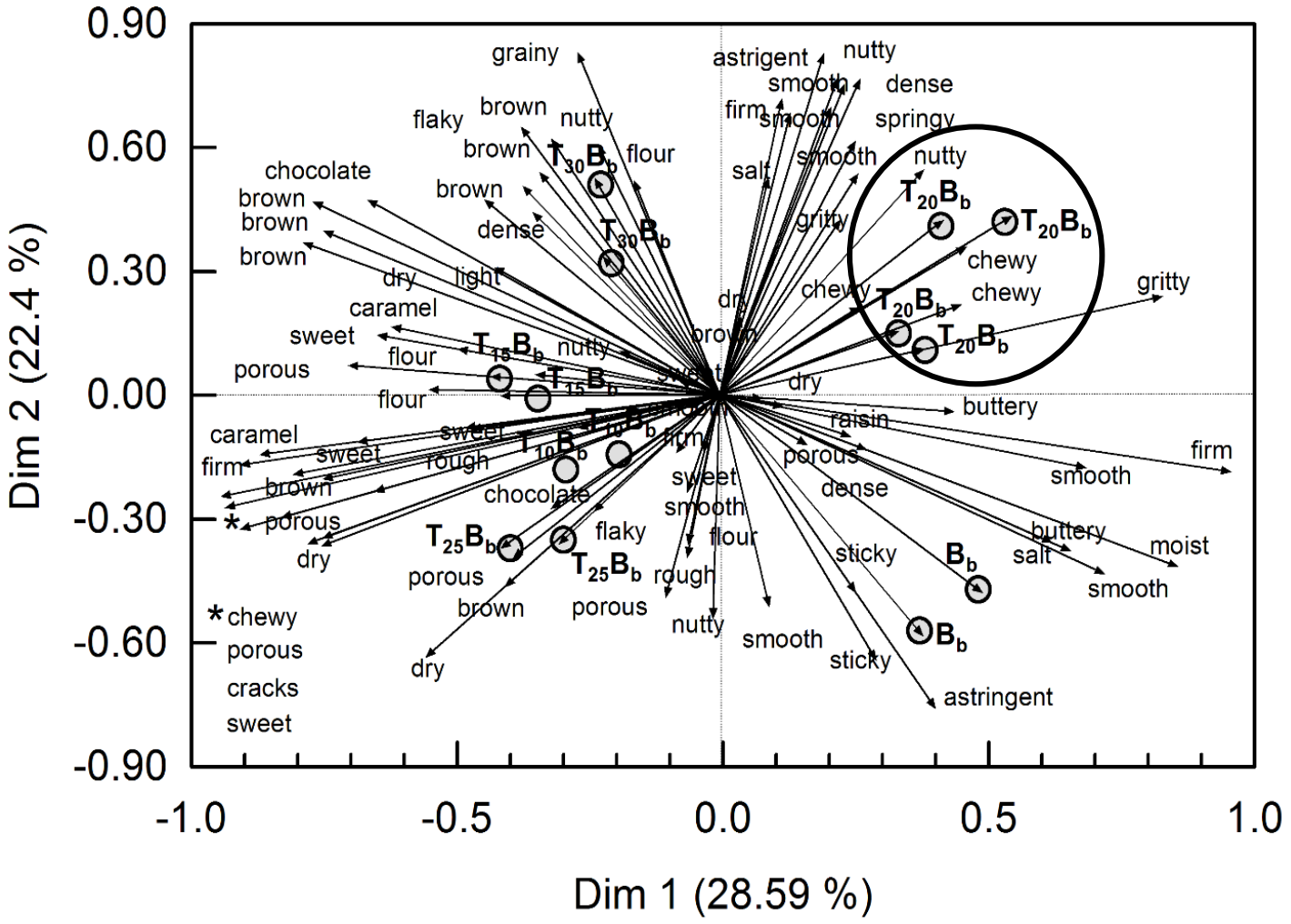
Results: Consumer (n=56) scores for butter, tea and sugar breads

- B_b: improved aroma (all levels); mouthfeel, acceptability (10 or 30 %); aftertaste, overall highest rating (10 %)
- T_b: Low consumer scores; improved all attributes, highest consumer rating (25 %)
- S_b: marginal improvement in consumer acceptance (30 %)

Bread type	WF:TNF composite	Crumb appearance	Crust appearance	Aroma	Mouthfeel	Aftertaste	Overall Acceptability
Butter bread	100:0	6.98 ± 0.27^{a}	6.74 ± 0.29^{a}	5.76 ± 0.34^{a}	6.32 ± 0.32^{a}	6.04 ± 0.32^{a}	6.50 ± 0.33^{a}
	90:10	7.06 ± 0.20^{a}	6.80 ± 0.25^{a}	6.80± 0.23^{b}	6.98± 0.27^{ab}	7.10 ± 0.27^{b}	7.56 ± 0.23^{b}
	85:15	6.02 ± 0.22^{b}	5.54 ± 0.29^{b}	6.26 ± 0.26^{b}	6.26 ± 0.26^{a}	6.52 ± 0.21^{a}	6.74 ± 0.20^{a}
	80:20	6.80 ± 0.21^{a}	6.52± 0.21^{a}	6.76 ± 0.17^{b}	6.42 ± 0.25^{a}	6.62 ± 0.21^{a}	6.92 ± 0.17^{a}
	75:25	6.48 ± 0.26^{ab}	6.26 ± 0.27^{ab}	6.22 ± 0.23^{b}	6.44 ± 0.21^{a}	6.58 ± 0.25^{a}	6.82 ± 0.23^{a}
	70:30	6.94 ± 0.22^{a}	6.80 ± 0.19^{a}	6.94 ± 0.17^{b}	7.00 ± 0.21^{b}	6.36 ± 0.18^{a}	7.32 ± 0.17^{b}
Tea bread	100:0	5.00 ± 0.22^{a}	5.61 ± 0.29^{a}	4.52 ± 0.22^{a}	4.65 ± 0.26^{a}	4.69 ± 0.24^{a}	4.81 ± 0.27^{a}
	90:10	6.37 ± 0.22^{b}	5.74 ± 0.25^{a}	5.46 ± 0.20^{b}	5.67 ± 0.22^{b}	5.41± 0.23^{b}	5.57 ± 0.23^{b}
	85:15	6.64 ± 0.20^{b}	6.22 ± 0.27^{b}	4.94 ± 0.28^{a}	5.50 ± 0.27^{b}	5.68 ± 0.25^{b}	5.64 ± 0.27^{b}
	80:20	6.66 ± 0.19^{b}	6.40 ± 0.23^{b}	5.34 ± 0.27^{b}	5.72 ± 0.28^{b}	5.86 ± 0.30^{b}	6.08 ± 0.25^{b}
	75:25	6.88 ± 0.14^{b}	6.64 ± 0.15^{b}	6.74 ± 0.18^{c}	6.98 ± 0.17^{c}	7.04 ± 0.15^{c}	7.18 ± 0.14^{c}
	70:30	6.82 ± 0.26^{b}	6.54 ± 0.15^{b}	6.76 ± 0.21^{c}	6.44 ± 0.27^{c}	6.50 ± 0.25^{d}	6.88 ± 0.25^{d}
Sugar bread	100:0	7.16 ± 0.27^{a}	6.62 ± 0.28^{a}	5.86 ± 0.27^{a}	6.22±0.27^{a}	6.10 ± 0.25^{a}	6.68 ± 0.24^{a}
	90:10	6.80 ± 0. 21^{a}	6.62 ± 0.24^{a}	5.80 ± 0.24^{a}	6.34±0.24^{a}	6.58 ± 0.19^{a}	6.52 ± 0.21^{a}
	85:15	6.86 ± 0.19^{a}	7.18 ± 0.16^{b}	6.10 ± 0.28^{ab}	6.50±0.23^{ab}	6.68 ± 0.19^{ab}	6.70 ± 0.21^{a}
	80:20	6.62 ± 0.17^{ab}	6.40 ± 0.22^{a}	5.78 ± 0.25^{a}	6.36 ± 0.25^{a}	6.44 ± 0.25^{ab}	6.48 ± 0.25^{a}
	75:25	6.48 ± 0.26^{b}	6.26 ± 0.27^{a}	6.22 ± 0.23^{b}	6.44 ± 0.21^{ab}	6.58 ± 0.25^{ab}	6.82 ± 0.23^{a}
	70:30	6.50 ± 0.26^{b}	5.92 ± 0.31^{c}	6.32 ± 0.23^{b}	6.80 ± 0.22^{b}	6.58 ± 0.26^{ab}	6.86 ± 0.22^{a}

Results: GPA of group average plots for descriptors of Butter

- 26 different descriptors generated
- B_b: firm, moist, buttery, smooth and astringent
- $T_{10}B_b$: chewy, firm, sweet, porous, dry and caramel
- TNF affects bread attributes and can influence consumer acceptance



Results: Effects on proximate composition of breads

Nutrients	Tiger nut flour	*Butter bread		Tea bread		Sugar bread	
		Without tiger nut flour	with 10% tiger nut flour	Without tiger nut flour	with 25 % tiger nut flour	Without tiger nut flour	with 30 % tiger nut flour
Protein	6.55 ± 0.23	12.67 ± 0.35^{a}	11.86 ± 0.33^{b}	13.56 ± 0.28^{a}	11.14 ± 0.34^{b}	12.92 ± 0.09^{a}	10.90 ± 0.08^{b}
Fat	8.25 ± 0.06	15.29 ± 0.07^{a}	16.30 ± 0.08^{b}	9.03 ± 0.01^{a}	10.04 ± 0.01^{b}	10.50 ± 0.22^{a}	11.34 ± 0.22^{b}
Fibre	9.52 ± 0.11	1.29 ± 0.05^{a}	2.10 ± 0.04^{b}	1.07 ± 0.04^{a}	3.49 ± 0.01^{b}	3.15 ± 0.09^{a}	5.17 ± 0.06^{b}
Ash	2.59 ± 0.05	1.43 ± 0.04^{a}	1.62 ± 0.04^{b}	1.30 ± 0.06^{a}	1.89 ± 0.07^{b}	1.06 ± 0.02^{a}	1.56 ± 0.02^{a}
CHO	73.09 ± 0.30	69.32 ± 0.48^{a}	68.79 ± 0.46^{b}	75.04 ±0.25^{a}	73.45 ± 0.29^{b}	72.36 ± 0.17^{a}	71.04 ± 0.15^{a}

*Values in the same rows of bread categories marked by different superscripts are significantly different at $p<0.05$

- Bread products show

➢ improved content of fat, fibre and minerals

➢lower content of protein and carbohydrate

Conclusion

- Partial substitution of wheat flour with tiger nut flour (TNF) for bread
  - increased bread brownness & specific volume in the order: $S_b > T_b > B_b$
  - increased crumb firmness in the order: $S_b > T_b > B_b$
- 10 % TNF for B_b and 25 % TNF for T_b gave the highest consumer acceptance
- 30 % TNF improved some consumer-preferred attributes of S_b, but was not significant for overall consumer acceptance
- Substitution was important for improving fibre, fat and minerals and may be more relevant for improving the properties of B_b and T_b than S_b
- Future studies to focus on cost assessment and willingness-to-buy analyses

THANK YOU