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THE PARTICLE SIZE DISTRIBUTION OF SOLID FOODS AFTER HUMAN MASTICATION

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ABSTRACT

Bolus formation is a complex process for which two theories are generally accepted, both theories describe how food changes through the mastication process which results in specific properties of the bolus being detected in the mouth to initiate swallowing. This research aimed to identify how food type, portion size (2 g and 4 g) and subjects affects the fate of ingested food solids and their particle size distributions, and bolus moisture content at the swallow point. Then the dynamics of bolus formation up to and past the point of natural swallowing were investigated by the use of a single subject to identify key trends.

Trials involved up to five processed foods; subjects were asked to chew portions of food and expectorate the bolus at the point they felt ready to swallow, or to expectorate the bolus at a specific number of chewing cycles. The solids loss from the bolus and moisture content of the bolus was determined. Particle size distribution (PSD) was measured for the expectorated bolus, and the debris (solids rinsed from the mouth after the bolus).

The food type had the greatest influence on the bolus moisture content, loss of solids from the bolus and PSD of the bolus and debris fractions. Solids are lost from the bolus progressively from the first chew cycle. PSD differed significantly between the bolus and debris fractions, and the PSDs were characteristic for each food type. The rate of change in PSD appears to plateau near the swallow point for some foods, whilst moisture addition continues to increase up to and past the point of swallowing. The bolus moisture content at the swallow point was approximately 50%, despite the differences in chewing strategy between subjects. Saliva does not appear to be added at a constant rate due to no significant effect of portion size.

The results from these studies indicate that bolus does not have to meet specific particle size criteria to achieve a safe swallow, and that particles circulate in multiple compartments during mastication. Results suggest a defined moisture content is required for a safe swallow.

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Flynn, C. S., Foster, K. D., Bronlund, J. E., Lentle, R. G., Jones, J. R. & Morgenstern, M. P. (2012). Changes to bolus moisture during mastication of selected processed foods. *Food Quality & Preference – Manuscript under review*.

Conference presentations

Lawrence, C. S.*, Bronlund, J. E., Jones, J. R., Lentle, R. G., Morgenstern, M. P. & Foster, K. D. *The effect of food type on the particle size distributions of the bolus and remaining particles after human mastication*. Biomouth Symposium, Auckland, NZ, 13-14 December 2006 (*Oral presentation).

Lawrence, C. S.*, Lentle, R. G., Foster, K. D., Bronlund, J. E., Jones, J. R. & Morgenstern, M. P. *Are sensory panel descriptions related to food breakdown in the mouth?* NZIFST Conference 2007: Food – The Challenges, Wellington, NZ, 19-21 June 2007. (*Oral presentation).

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LIST OF NOMENCLATURE

ANOVA	Analysis of variance
BMI	Body Mass Index
CPG	Central Pattern Generators
d.p.	Decimal place
DMB	Dry Mass Basis
EMG	Electromyography
IDM _{food}	Ingested dry food solids (g)
K-S test	Kolmogov-Smirnov test
LSD	Least Significant Difference
M _{(d)bolus}	Mass dry bolus (g)
M _{(d)food}	Mass dry food (g)
M _{(d)pellet}	Mass dry food centrifuge pellet (g)
m.s.	mean square
M _{bolus}	Mass wet bolus (g)
MC _{bolus}	Moisture content bolus (g/100 g dry solids)
MC _{food}	Moisture content food (g/100 g dry solids)
M _{food}	Mass wet food (g)
M _{pellet}	Mass wet food centrifuge pellet (g)
M _{sample}	Mass of ingested sample (g)
MSDS	Material Safety Data Sheet
N _{chew}	Chew cycle number
P	Probability
PC	Principal Components
PCA	Principal Component Analysis
PSD	Particle Size Distribution
SEM	Standard Error of the Mean
S _{insol}	Insoluble solids (%)
S _{loss}	Bolus solids loss (g/100 g dry solids)
S _{sat}	Saturated solids (g/100 g dry solids)
S _{sol}	Soluble solids (%)

t_{chew}	Chewing time (s)
TMJ	Temporomandibular Joint
TPA	Texture Profile Analysis
VFG	Videofluorography
WHC	Water holding capacity
WMB	Wet Mass Basis
$\Delta\text{MC}_{\text{bolus}}$	Change in moisture content of the bolus (g)
ν_{chew}	Chewing frequency (1/s)