

## Appendix: Seed displacement method for measuring food volume and its validation

Seed displacement is commonly used to measure food portion size in which the volumetric difference is indicated by a marked container (e.g. a glass measure) before and after a food submersion. In our study, we modified this method to provide a more precise gold standard for comparison with the result obtained by eButton. The container utilized was a dining plate with a plastic circular fence (see Fig.A). After filling in seeds with a food sample submerged (covered by a plastic wrap when necessary), a straight-edge ruler was used to level the seeds on top of the fence. In order to obtain a more reliable measure, the container was placed on a shaker (vibrator) at a speed of 100 rounds per minute (RPM) for one minute following by refilling and re-leveling. Then, the seeds in the plate, but outside the fence, were removed with a brush and the weight was measured using a kitchen scale. The weight of the seeds ( $W_{seeds}$ ) was calculated by subtracting the weight of food sample ( $W_{sample}$ ) and the weight of container ( $W_{container}$ ) from the total weight ( $W_{total}$ ), i.e.,  $W_{seeds} = W_{total} - W_{sample} - W_{container}$ . The volume of the sample ( $V_{sample}$ ) was then calculated as  $V_{sample} = V_{container} - W_{seeds}/\rho_{seeds}$ , where  $V_{container}$  is the volume of the container, and  $\rho_{seeds}$  is the density of seeds which was the ratio of the measured weight of the seeds and the volume of the container without submerging a food sample.

To validate our seed displacement method, we conducted an experiment to compare the measured volume using both seed and water displacement. Eight water-resistant food replicas (NASCO, Fort Atkinson, WI) were utilized, including a scoop of ice cream, one half of an egg, a roasted potato, a pile of brown rice, a bun, a peach, a chicken thigh, and a hamburger (Fig.B). The volume of each food replica was first measured three times using the water displacement method. Then, the volume of each food replica was measured three times again using the seed displacement method described previously. A repeated Bland–Altman plot highlighted a very good agreement between these two methods, with a mean bias of 0.5 ml(Fig.C).

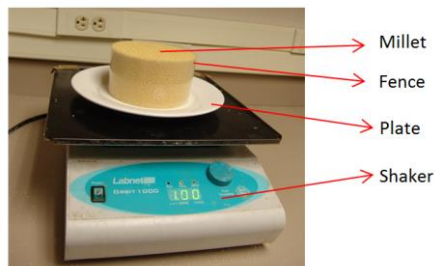


Fig. A. Container and shaker used for the measurement



Fig.B. Food replicas used in this experiment.

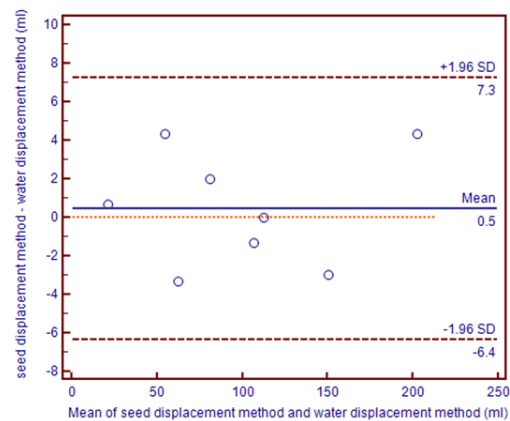


Fig.C. Bland–Altman plot to compare the volumes measured by water displacement and seed displacement. The horizontal axis represents the average of the volumes measured by the two methods. The vertical axis represents the difference between these two methods.