

Measuring Density Using Seed Displacement

Phyllis J. Stumbo, PhD

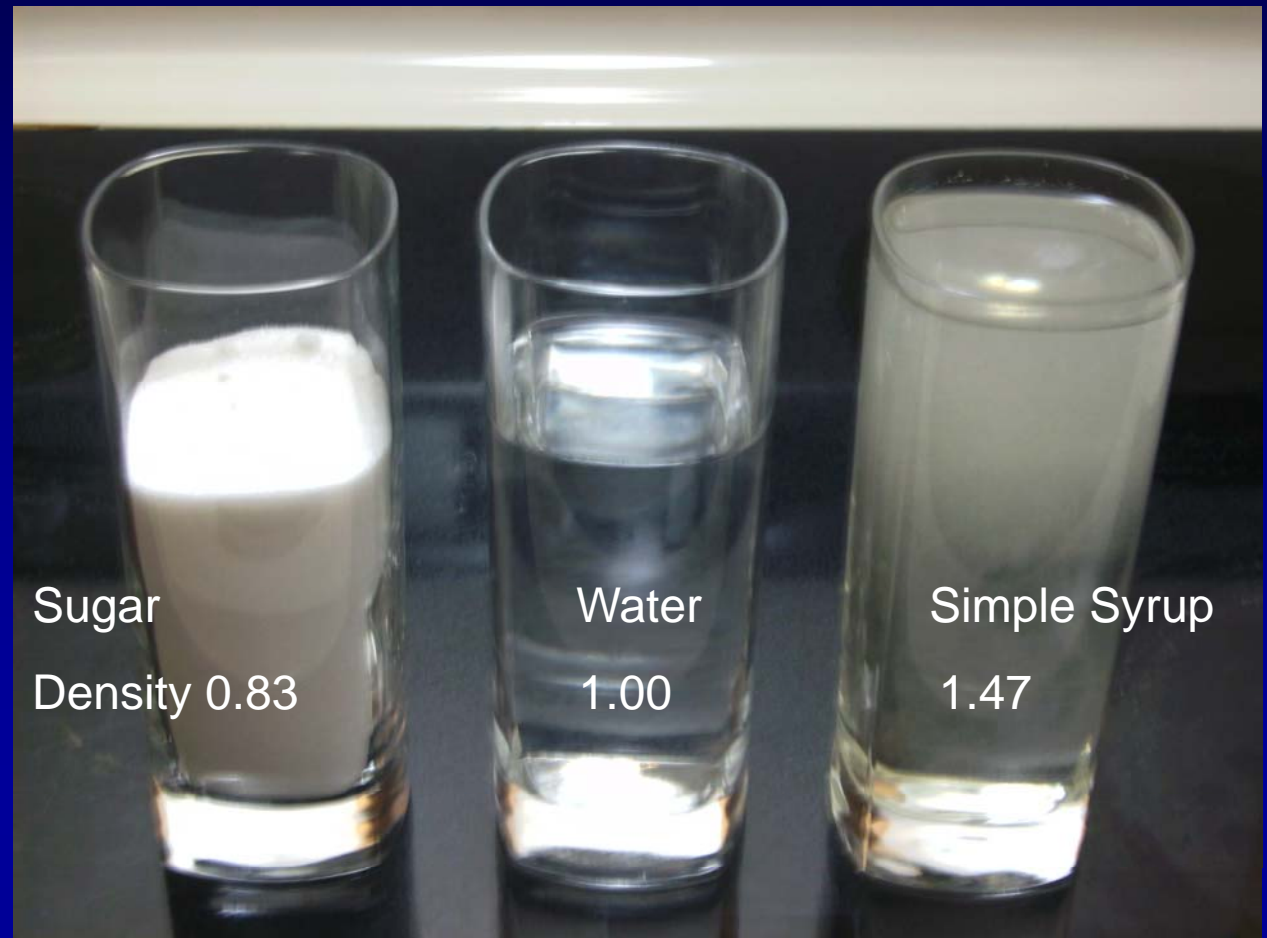
Institute for Clinical and Translational Science
University of Iowa



Item	Wt/Cup	Density
Water	237	0.988
Lard	205	0.854
Salt	292	1.217
Calcium Carbonate		2.71

1 cup sugar
+ 1 cup water
= 1 ¼ c syrup

Density 0.8 to
1.5



Visualization in a nutshell

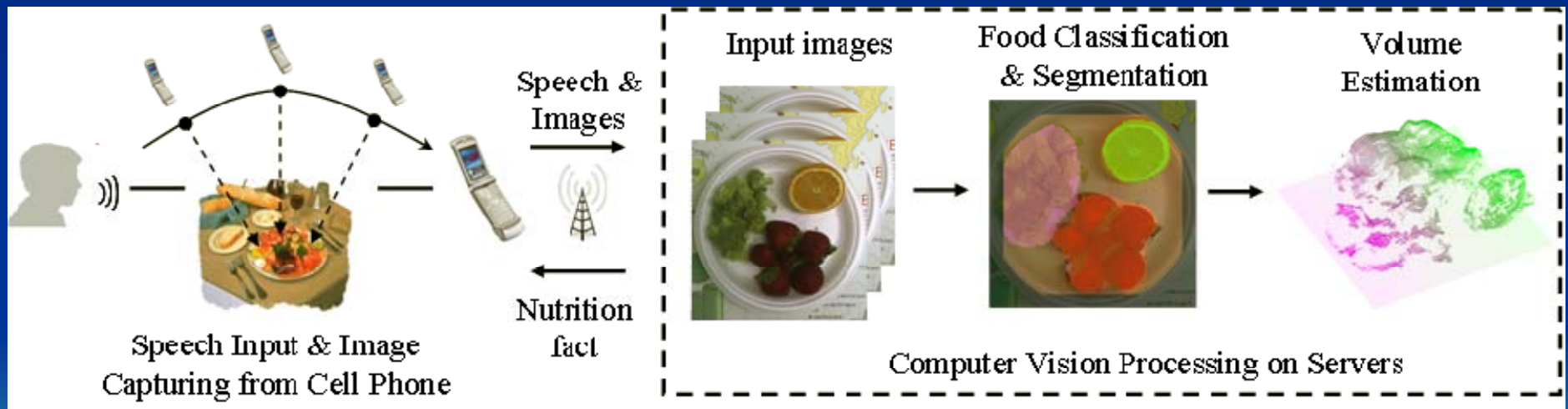
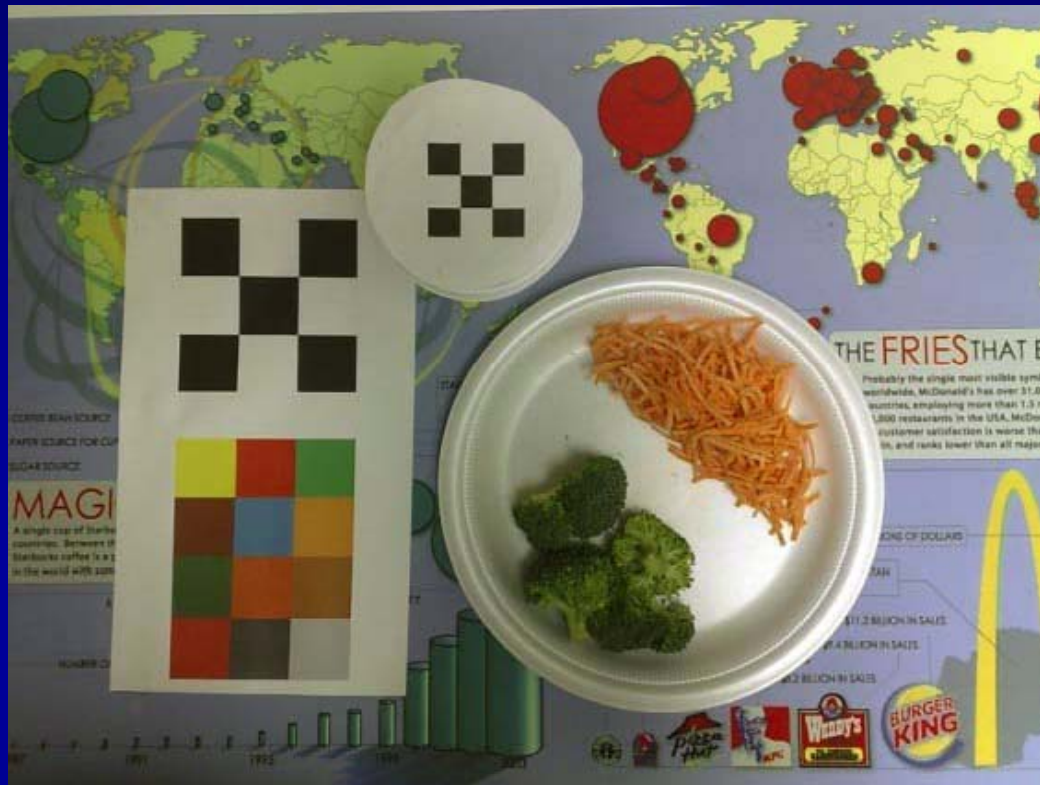
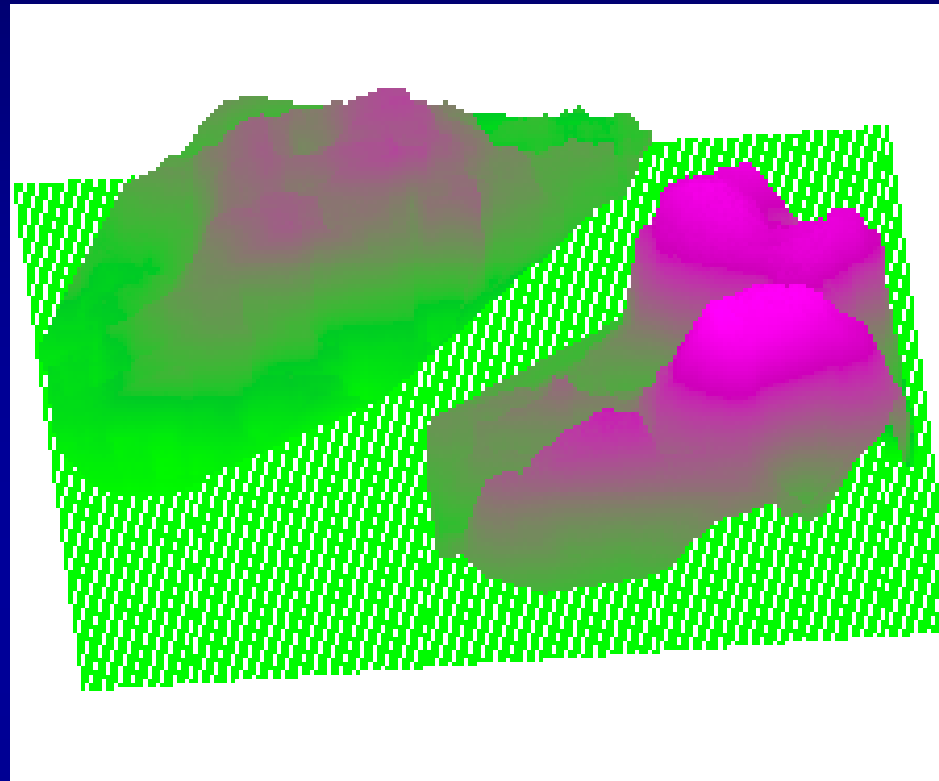


Plate of food



Camera interpretation of foods





Density Values on FNDDS

Most FNDDS foods have both volume and weight measures, about $\frac{1}{4}$ do not:

- Sandwiches
- Frozen dinners
- Some casseroles (lasagna)
- Candy bars
- Chicken Feet



Density calculation for FNDDS
foods uses this formula:

$$\text{Cup Weight} / 240 = \text{Density}$$



Beverages 1.02 +/- 3%

Water	0.988
Diet Soda	0.988
Chocolate Flavored Soda	1.025
Root Beer	1.029
Orange soda	1.033
Apple juice	1.033
Orange Juice	1.033
Orange Juice with Calcium	1.038
Grape Juice	1.054

Soup Density 1.025 +/- 3%

Chicken Noodle, Beef Noodle	1.000
Egg Drop Soup	1.017
Chicken Mushroom Soup	1.017
Ox Tail Soup	1.017
Sweet and Sour Soup	1.017
Beer Soup	1.021
Tomato Soup	1.034
Cheddar Cheese Soup	1.046
Bean Soup	1.054

Casserole (28 items) 0.908

Mexican Casserole w/ground beef	0.600
Eggplant/meat casserole-Moussaka	0.846
Kraft Macaroni and Cheese	0.904
Chicken & Noodles w/cream sauce	0.933
Broccoli Casserole	0.950
Green Bean Casserole	0.950
Tuna Casserole w/veg & cream sauce	1.017
Zesty Italian "Hamburger Helper"	1.04
Tuna Casserole w/veg/cream sauce	1.017

“Mixtures” (284 items) mean=0.908

Beef & Noodles +32 others “no sauce”	0.670
Beef Tofu & veg – soy-based sauce	0.904
Sausage and rice with cheese sauce	1.017
39 other “mixtures”	1.017
Swedish meatballs	1.025
Chicken and Dumplings	1.038
45 other “mixtures”	1.038
Beef stew with tomato-based sauce	1.050
Beef with BBQ sauce	1.095

Canned Mixed Dishes 1.00 +/- 10%

Mini ravioli, canned	1.053
Chili con carne, canned	1.053
Spaghetti and meat balls	1.050
Campbell Spaghettos	1.050
Beef Ravioli	1.017
Beef Macaroni	1.000
Chili, con carne, canned	1.053
Beef Stew, canned	0.967

Density, Other Foods

Hot Cereal – Oats	0.975
Hot Cereal – Cream of Rice	1.016
Hot Cereal – Corn Grits	1.042
Baked Custard	1.175
Jello (gelatin dessert)	0.975
Scrambled eggs	0.917
Rice, short grain	0.813
Rice, medium grain	0.792
Rice, long grain	0.658

Food Group	Item	Wt. 1 cup	Density
Apples	Raw, sliced	109	0.454
	Canned, sliced	204	0.850
	Canned, sauce	244	1.016
	Canned; sauce sweetend	255	1.062



Food Group	Item	Wt. 1 Cup	Density
Other Fruit	Grapes, whole	151	0.629
	Pineapple chunks	165	0.687
	Banana, sliced	150	0.625
	Banana, mashed	225	1.062



Density-Frozen Meals 0.8 +/- 10%

Lean Cuisine Garlic Chicken	0.88
Lean Cuisine Lemon Pepper Fish	0.85
Lean Cuisine Shrimp w/ Broccoli/Peas	0.83
Lean Cuisine Shrimp Stir Fry	0.83
Smart Ones Chicken Fettuccini	0.80
Hungry Man classic fried chicken	0.79
LC Meatloaf, Gravy, Mashed Potato	0.78
Healthy Choice Herb Chicken	0.78
Healthy Choice Lemon Pepper Fish	0.73

Density-Frozen Meals 1.00 +/- 10%

Lean Cuisine Chicken Fettuccini	0.94
---------------------------------	------



Ice Cream, Milk and Cream

Ice Cream, fat-free	0.517
Ice Cream, sugar-free	0.575
Ice Cream, rich	0.600
Sherbet	0.617
Milkshake	0.946
Cream, whipping	0.992
Cream, half and half	1.008
Milk, whole	1.017
Milk, skim	1.021

Chicken Feet (Raw & Prepared)



Wikipedia: Most of edible meat consists of skin and tendons, without much muscle giving a distinct texture difference from rest of chicken meat.

Chicken Feet

Ingredients:

Soy Sauce

Rice wine

Fresh ginger

Green Onions

BBQ Sauce

Sugar

Star Anise

Orange Rind

Pepper

Cuisines:

Chinese

Trinidadian

Jamaican

So. African

Peruvian

Philippine

Source:

Wikipedia

FNDDS Items Lacking Volume Measure

Candy	Density
Mini Charleston Chews	0.726
Reece's Nutrageous	0.947
Milky Way	1.070
100 Grand	1.077
Zagnut	1.082
5 th Avenue	1.100
Snickers	1.112
Nestle Oh Henry	1.242

FNDDS Items Lacking Volume Measure

Sandwiches	Density
Peanut Butter sandwich	0.258
Peanut Butter & Jelly Sandwich	0.387
Hot Dog on Bun	0.387
McDonald Fish Sandwich	0.432
McDonald Quarter Pounder	0.471
Hardee's Sausage and Egg Biscuit	0.680
Hardee's Ham, Egg and Cheese	0.663
Hardee's Ham and Egg	0.585

Density, Foods with extra air

Whipping Cream	0.992
Whipped Cream	0.496
Ice Cream	0.600
Angel Food Cake	0.195
Bread	0.182
Meringue	0.032

Summary:

- Completely hydrated foods have a density of approximately 1.0. (Beverages, soups, canned mixtures, casseroles, cooked fruits)
- Solutes such as sugar increase density by about 10% (sweetened beverages)
- Air within food matrix and surrounding pieces reduce density by approximately 50% (ice cream, sliced and small fruits)
- Leavened products have the lowest density of foods studied so far (bread, cake, airy desserts)



The Next Steps:

- Validate camera derived volumes using standard volumetric containers and seed displacement techniques
- Develop defaults based on food characteristics

Thank You for your Attention

Rick Weiss & Team, Viocare Inc., Princeton, NJ

Ajay Divakaran & Team, Sarnoff Inc., Princeton, NJ

Phyllis Stumbo, University of Iowa

