

How Much Air is in Your Bag of Chips?

By Katrina Apiado and Ranjeet Nebhnani

Purpose

Problem:

There are branded bags of potato chips that look to be filled with more air and we can't tell how much chips we are getting in these bags.

Goal:

We want to identify which brand of potato chips has the lowest and highest chip-to-air ratio.



Hypothesis

At the moment we have no idea how to rank different brands of potato chips based on the air content of their bags.

Null Hypothesis

$$H_0 = \mu_{\text{Lays}} = \mu_{\text{Ruffles}} = \mu_{\text{Kettle}} = \mu_{\text{Cape Cod}}$$

Alternative Hypothesis

H_1 = There is at least one brand of chips whose chip density is different from the other brands.



Experimental Design

Factor

Potato chip brand

Trials

5

Levels

- Lays
- Ruffles
- Cape Cod
- Kettle

Response Variable

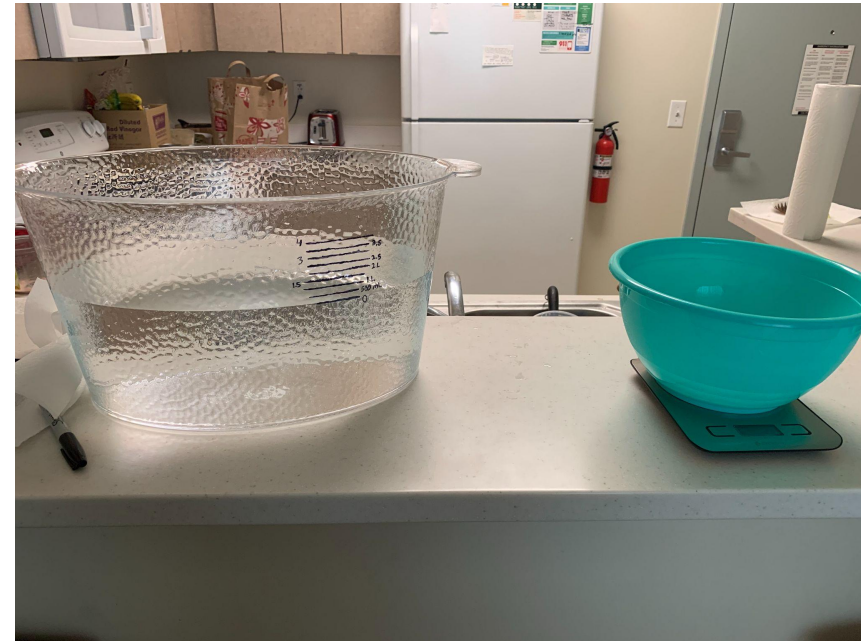
Chip-to-air ratio $\rho = \frac{m}{V}$



Procedure



Bags of chips used in experiment



Bucket for water displacement, large bowl, food weighing scale, & measuring cup

Procedure

Step 1

Measure the volume of an unopened bag of chips via water displacement



Step 2

Measure the weight of the chips contained in a bag (crumbs are negligible)



Step 3

Record measurements and calculate the Chip-to Air ratio (grams of chip/ mL in bag)

Results

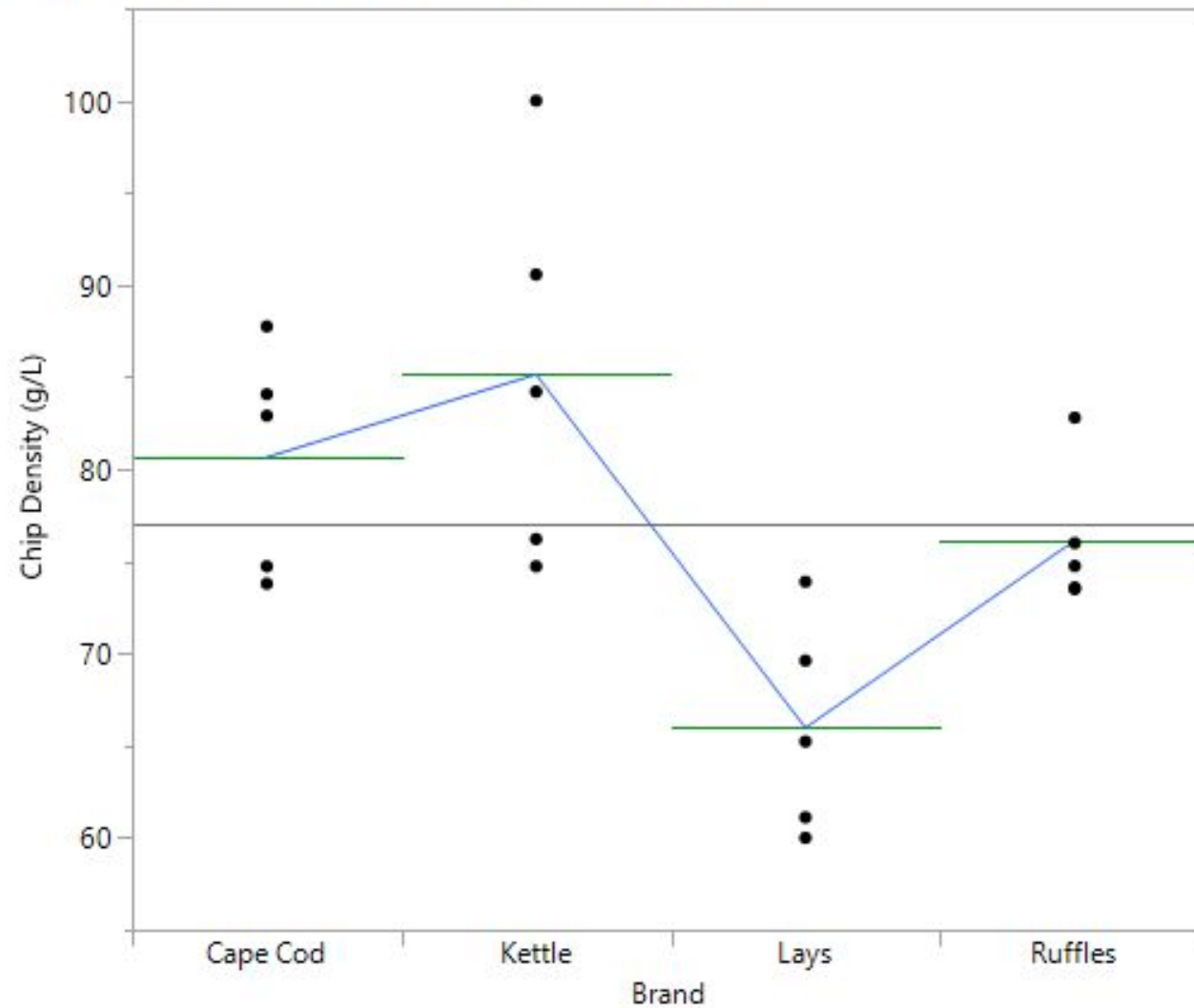


	Avg. Chip weight (g)	Avg. Bag volume (L)	Avg. Chip Density (g/L)
Lays	217.8	3.322	65.56
Ruffles	226	2.98	75.84
Kettle	201.6	2.34	86.15
Cape Cod	219.4	2.73	80.37



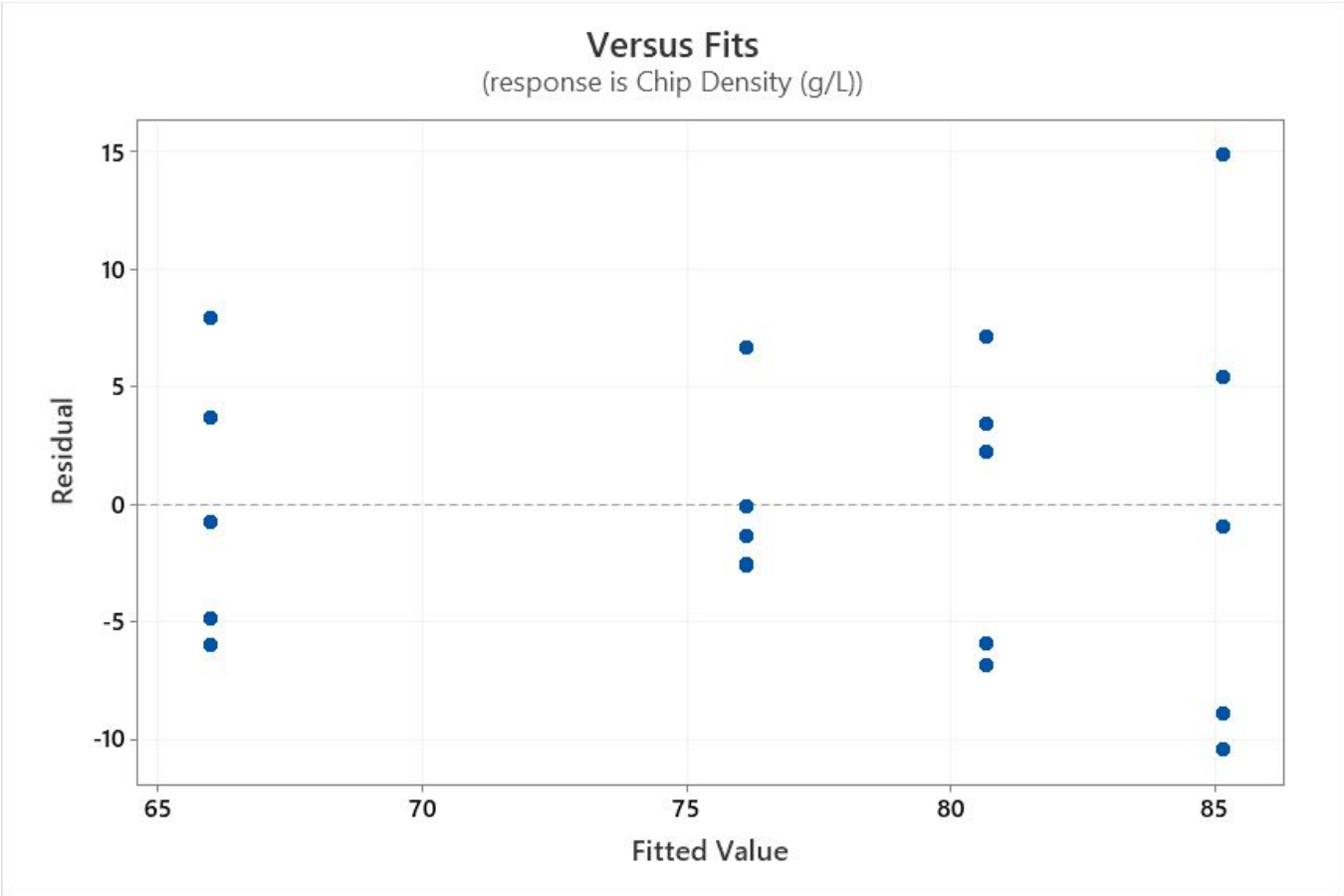
Collected Data

Oneway Analysis of Chip Density (g/L) By Brand



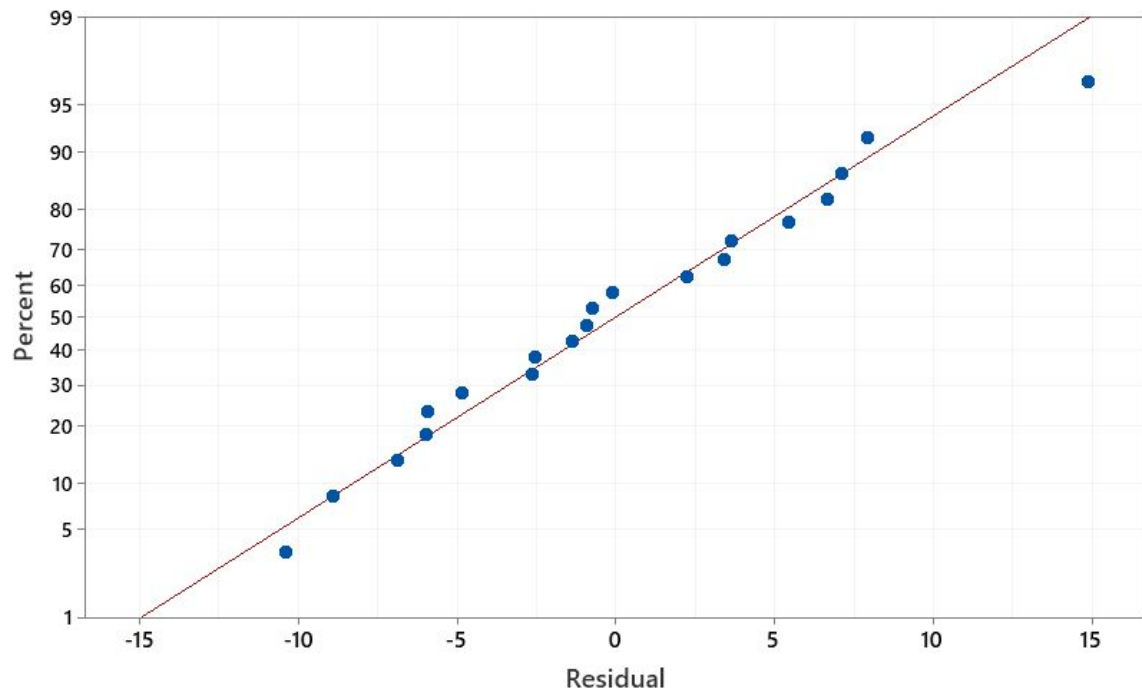
Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Brand	3	1010.4	336.80	6.87	0.003
Error	16	784.1	49.00		
Total	19	1794.4			

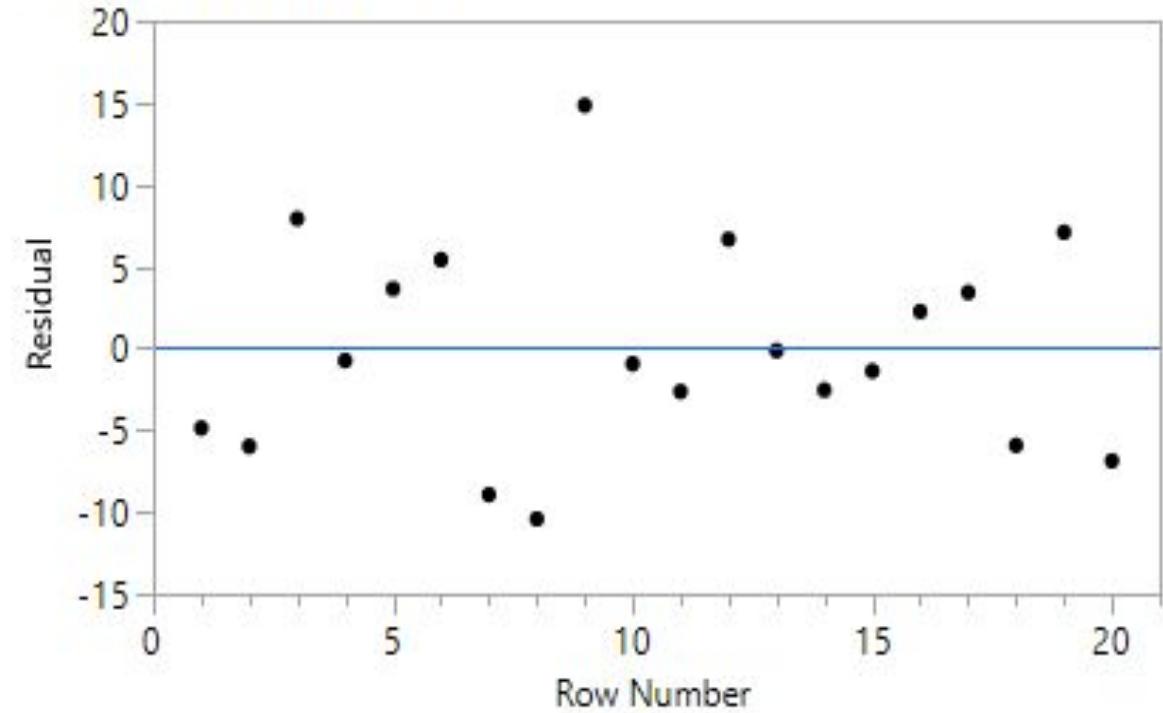


Checking Assumptions

Normal Probability Plot
(response is Chip Density (g/L))



Residual by Row Plot



Tukey's Method

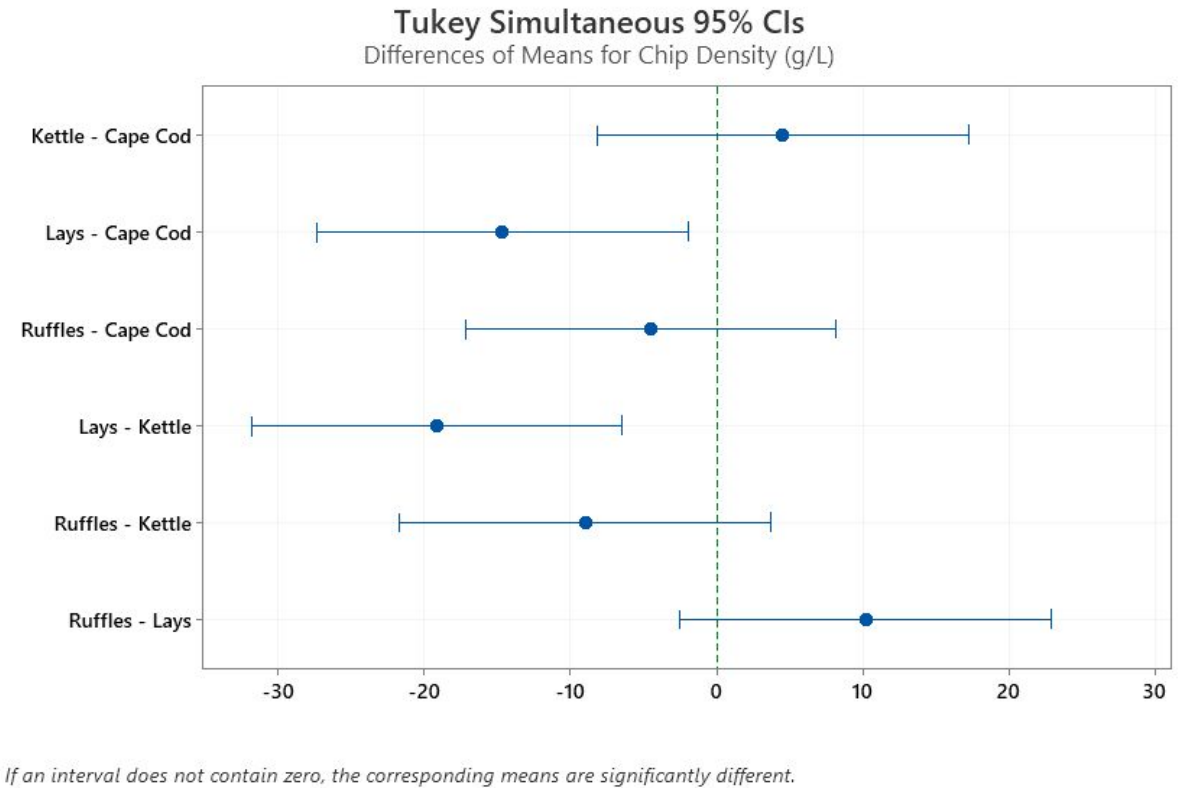


Lay's is significantly different than Kettle and Cape Cod

Grouping Information Using the Tukey Method and 95% Confidence

Brand	N	Mean	Grouping	
Kettle	5	85.15	A	
Cape Cod	5	80.65	A	
Ruffles	5	76.13	A	B
Lays	5	65.97	B	

Means that do not share a letter are significantly different.



Fisher's Method

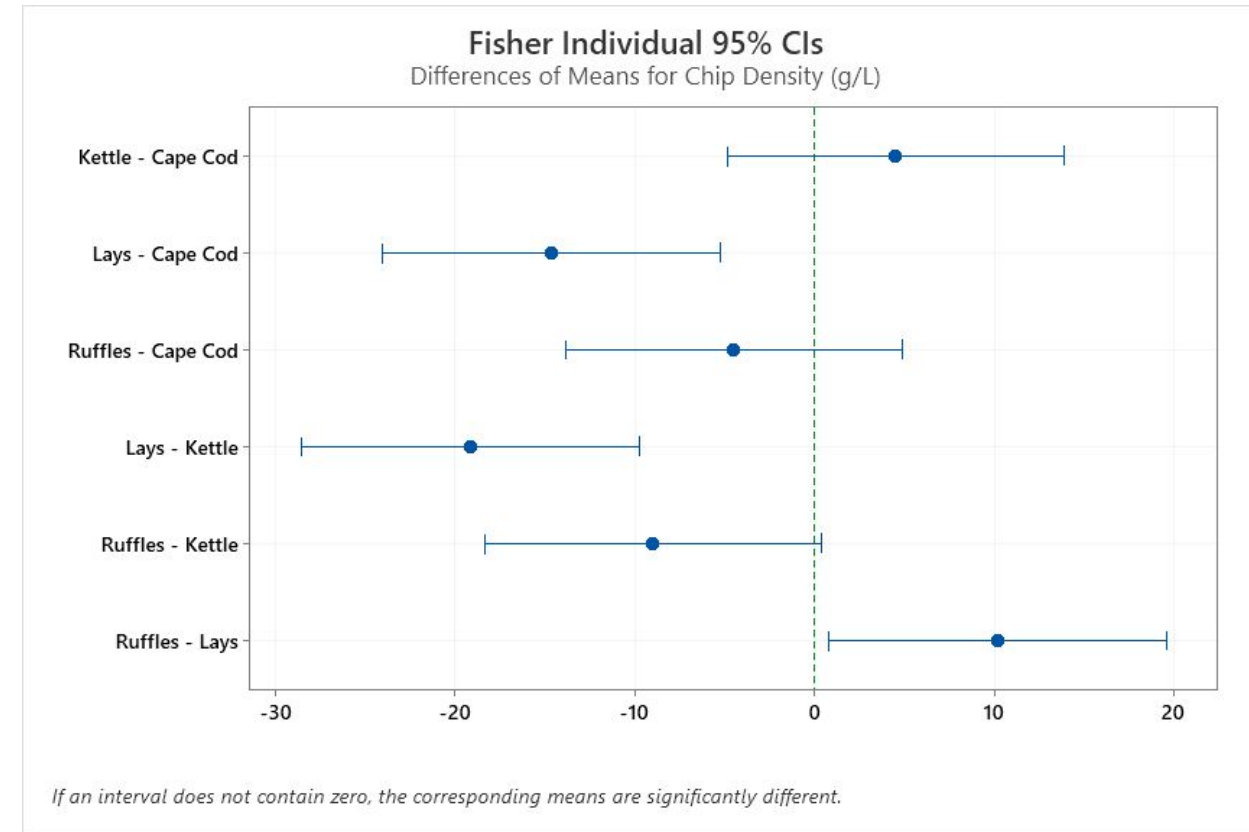


Lay's is significantly different than the rest

Grouping Information Using the Fisher LSD Method and 95% Confidence

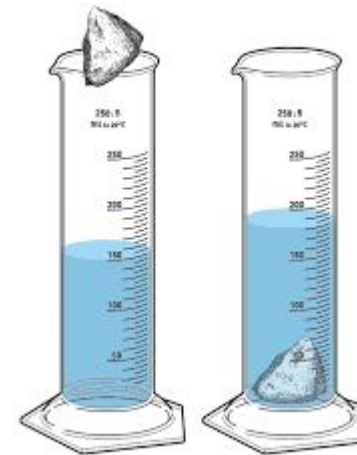
Brand	N	Mean	Grouping
Kettle	5	85.15	A
Cape Cod	5	80.65	A
Ruffles	5	76.13	A
Lays	5	65.97	B

Means that do not share a letter are significantly different.



Errors and Improvements

- Measuring volume
 - Water Displacement method for light objects
 - Submerge mags with dense object
- Sample Size



Further Research

- Factor: Corn chip brand



- Air-fried potato chips vs. oven-baked potato chips
 - Not much oil compared to directly frying potato slices

Conclusion

We can reject the null hypothesis that all of these bags of chips have the same chip-to-air ratio at a 95% confidence interval. It was proven that there was a statistical difference in means at a 95% confidence level with one brand of chips having the lowest chip density.

Best Brands*: *Kettle & Cape Cod*



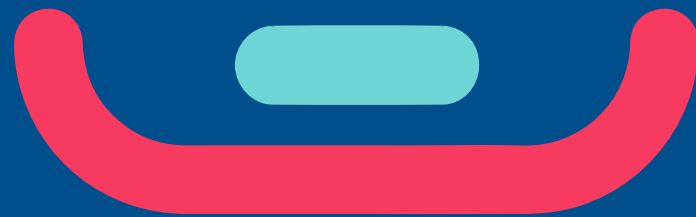
Highest Chip-to-Air ratio



Worst Brand: *Lay's*



Lowest Chip-to-Air ratio



THANK YOU!

Any Questions?

