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Separation whole raisin berries by physical and aerodynamic properties

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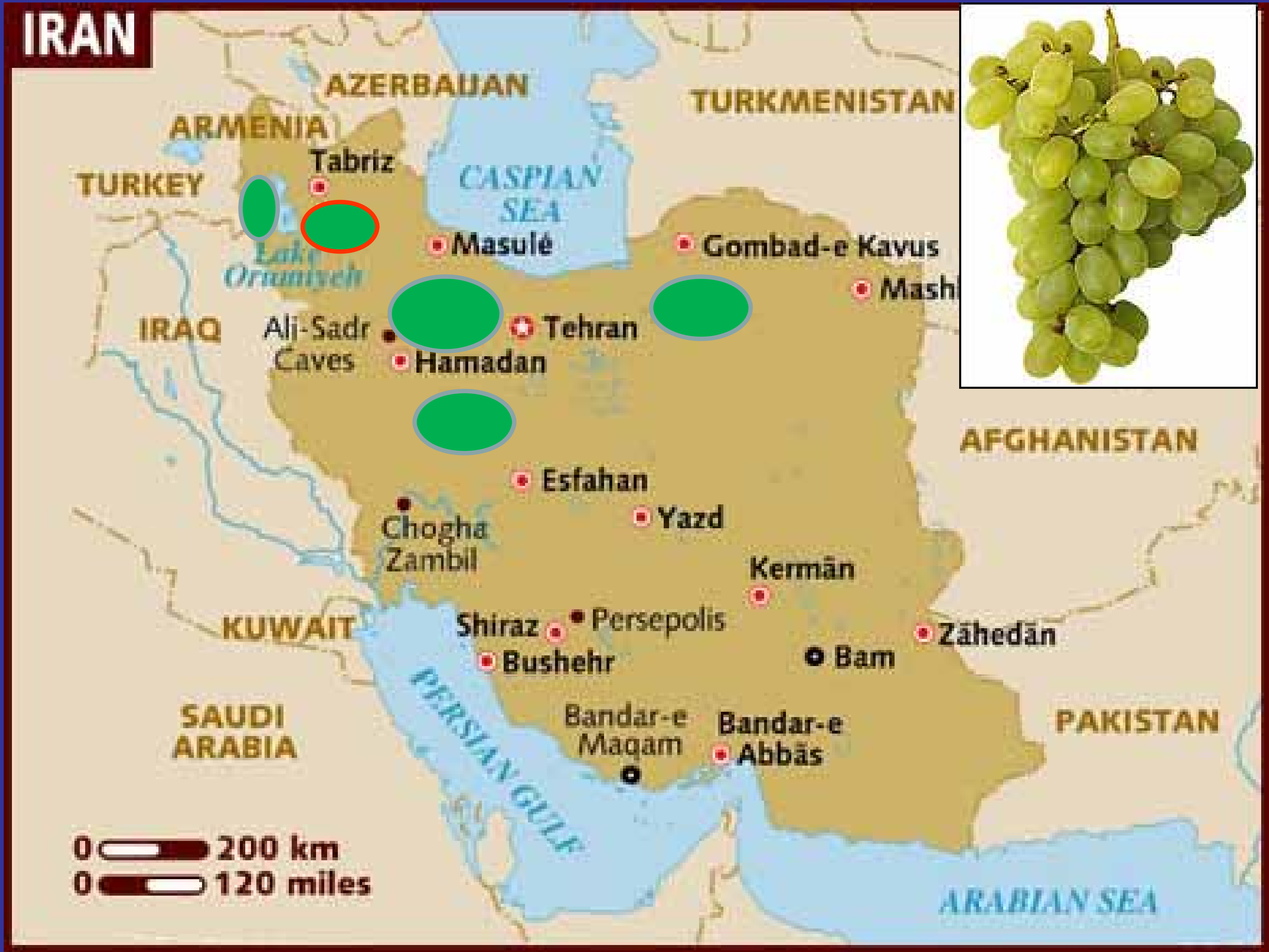
❖ Introduction

Field area: 850,000 ha

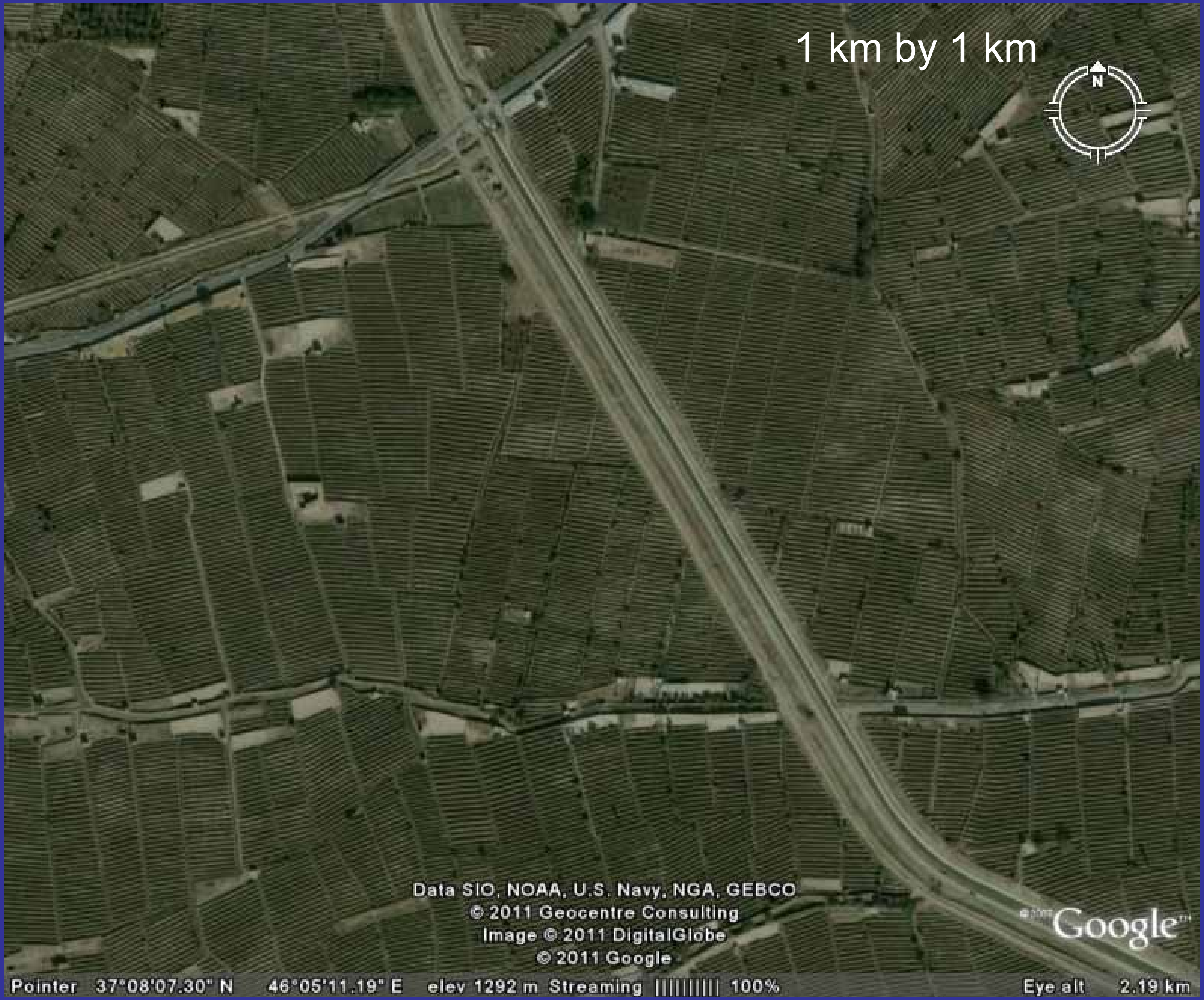


❖ Introduction

Research area

❖ Introduction

Farms



Producing Methods for raisins

- On the trees
- Spreading on trays or ground
- Immersing in hot water
- Hanging in shadow

❖ Producing Methods for raisins

Varieties

Golden Bleached

Sun Dried

Sultana

❖ Introduction

• Turkey	1/3
• USA	15%
• Iran	15%
• Greece	8%
• Chili	7%
• Others	20%

Problem

- Iran is the 2nd or 3rd raisin producer
  - Low quality
  - No interest by costumers
  - No success in global market competition
  - Short shelf life
  - Economical disadvantageous

❖ Introduction

- Exportation problems

  - Transportation
  - Packing
  - Storage
  - Bureaucracy
  - Less sight about international market

Introduction

- Grading standard
  - Raisins attached together
  - Damaged raisins
  - Immature raisins
  - Tailed raisins
  - Extra materials
  - MC level
  - Infections

Objective

- Physical properties
- Aero dynamical properties
- Distribution

Modify the current processing systems

Materials and Methods

- Golden bleached raisins
- 110 random samples
- Whole and defected raisins
- 16% moisture content

❖ Materials and Methods

- Moisture content — by oven
- Dimensions — Length, Width and Thickness
- Mean diameter — $D_g = (LWT)^{0.333}$
- Projected area — $A_p = (\pi/4)D_g^{2}$
- Bulk density
- True density
- Porosity — $\varepsilon = 1 - (\rho_b / \rho_f)$
- Mass — 0.01 g

❖ Materials and Methods

- **Coefficient of friction**
- **Static and dynamic coefficients**
- **On wood, iron steel and galvanized steel sheets**
- At 16% MC

❖Materials and Methods

- **Experimental Terminal Velocity, v_t**

- **Drag coefficient** $C_d = mg/v_t^2 \rho_a A_p$

- 50 samples for whole and defected berries

Results and discussion

- Static and dynamic friction properties

Characteristics	Replication number	Mean value	Range of values	Standard deviation
Coefficient of static friction on				
Unpolished wood	5	0.49	0.47 – 0.51	0.01
Galvanized steel sheet	5	0.39	0.34 – 0.43	0.03
Iron steel sheet	5	0.45	0.41 – 0.46	0.02
Polyethylene	5	0.41	0.39 – 0.42	0.02
Coefficient of dynamic friction on				
Unpolished wood	5	0.45	0.43 – 0.47	0.01
Galvanized steel sheet	5	0.37	0.33 – 0.39	0.02
Iron steel sheet	5	0.42	0.32 – 0.47	0.05
Polyethylene	5	0.39	0.35 – 0.44	0.04
Dynamic angle of repose (°)				
Polished wood	10	17.11	16.28 – 18.21	1.05
Galvanized steel sheet	10	21.02	19.76 – 21.16	0.8
Iron sheet	10	21.36	21.15 – 22.34	0.6
Static angle of repose (°)	5	33.45	33.05 – 34.13	0.9

Results and discussion

- Aerodynamically properties

Characteristics	Replication number	Mean value	Range of values	Standard deviation
Whole raisin berries				
Experimental terminal velocity (m/s)	50	8.04	6.78 – 9.61	1.02
Drag coefficient	50	0.498	0.18 – 0.43	0.05
Demolished raisin berries				
Experimental terminal velocity (m/s)	50	6.18	5.21 - 7.31	1.21
Drag coefficient	50	0.701	0.06 – 1.15	0.26

Results and discussion

- Dimensions

Dimention (mm)	Sample type	Samples	Mean value	Range	Standard deviation
Length	Whole	110	12.45	6.4 – 16.36	2.03
	Defected	110	8.6	3.91 - 9.86	1.2
Width	Whole	110	9.59	5.36 – 14.16	1.5
	defected	110	5.34	2.06 – 8.67	1.37
Thickness	Whole	110	6.93	4.01 – 10.38	1.26
	defected	110	2.88	1.09 – 4.89	0.96
Projected area (mm^2)	Whole	110	70.08	31.53-120.26	19.08
	defected	110	20.71	4.94-42.93	8.06

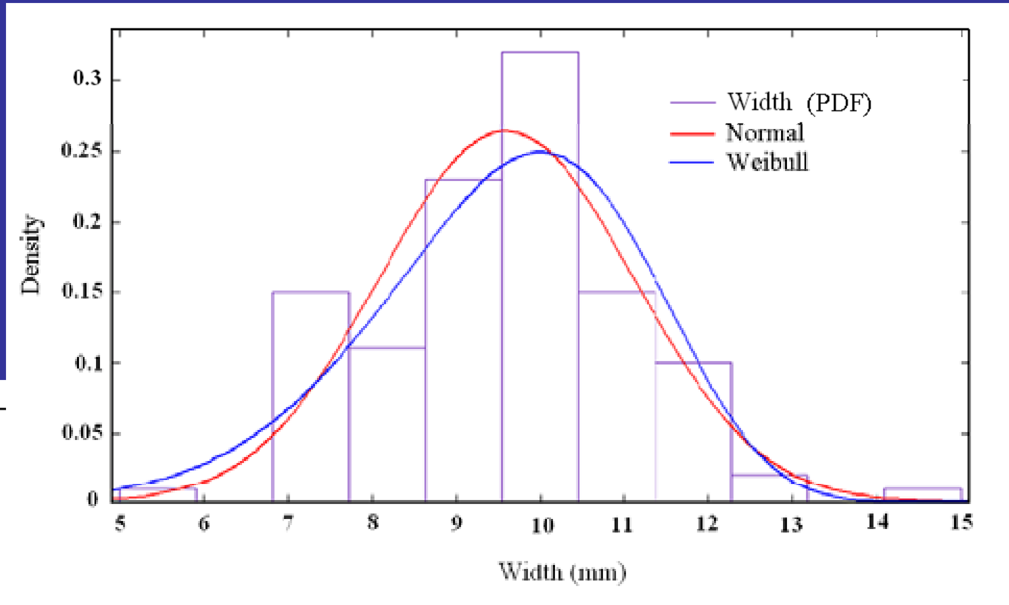
Results and discussion

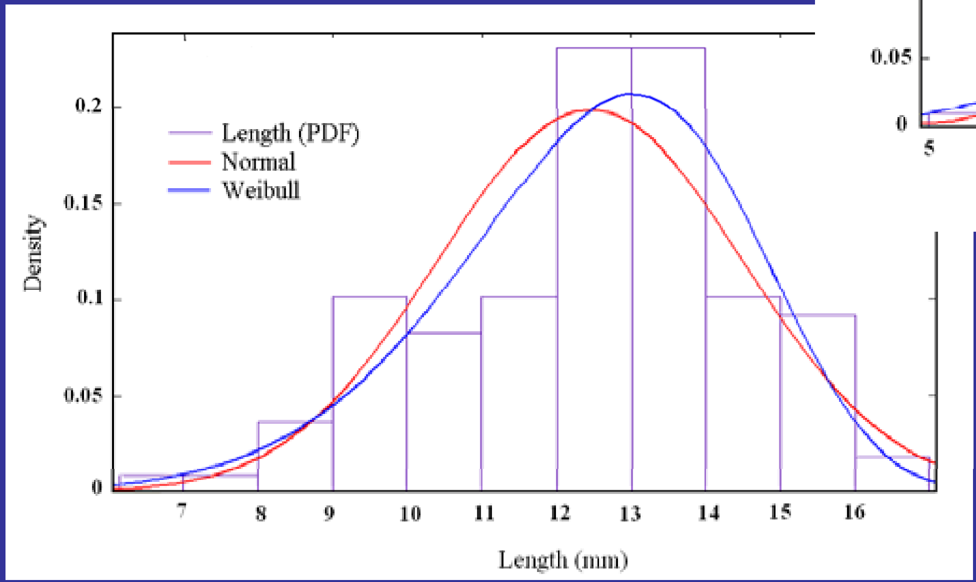
- Density properties

Characteristics	Sample type	Replication number	Mean value	Range of values	Standard deviation
Bulk density (kg/m^3)	Whole	10	763.23	755.45 – 771.25	11.25
	Defected	10	592.41	585.35 – 601.73	6.43
True density (kg/m^3)	Whole	10	1306.36	1251.41-1342.86	19.84
	Defected	10	1181.67	1168.37-1218.71	12.13
Porosity (%)	Whole	10	41.53	39.81- 43.03	2.01
	defected	10	50.61	49.12 – 51.78	2.6

❖ Results and discussion

- Distribution functions





Density of what?

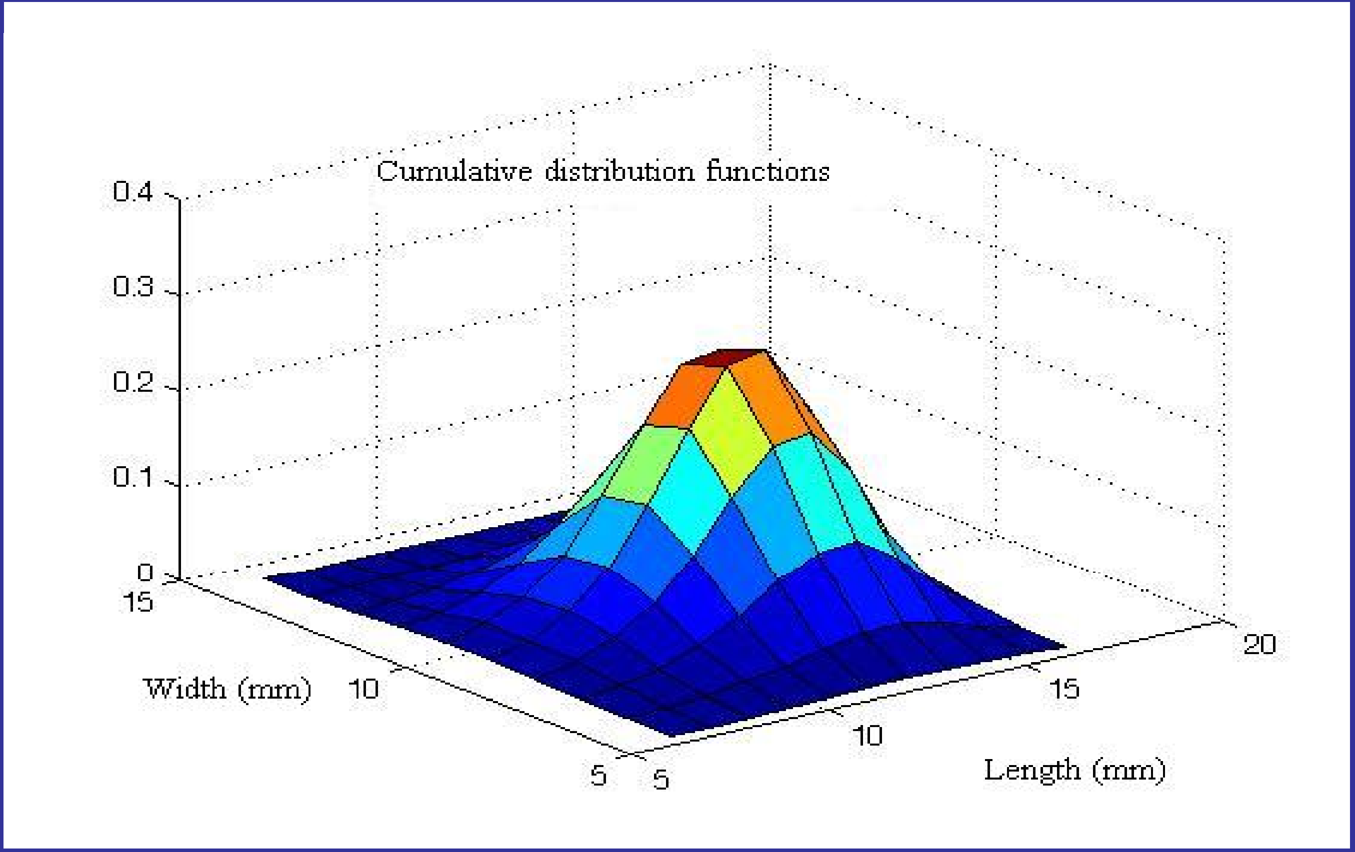
Results and discussion

- Cumulative frequency **Weibull** and **Normal** distribution

Length (mm), li	Cumulative frequency	Cumulative Weibull Distribution	Cumulative Normal Distribution	Width (mm) wi	Cumulative frequency	Cumulative Weibull Distribution	Cumulative Normal Distribution
6.4	1	0.46	0.14	5.36	1	0.11	0.23
7.4	1	1.35	0.64	6.36	1	1.67	1.53
8.4	4	3.42	2.3	7.36	12	7.80	6.76
9.4	9	7.67	6.64	8.36	22	21.79	20.42
10.4	19	15.43	15.62	9.36	48	43.90	43.64
11.4	31	27.98	30.25	10.36	76	68.68	69.38
12.4	46	45.48	49.01	11.36	97	87.65	87.96
13.4	77	65.62	68.01	12.36	107	96.92	96.71
14.4	91	83.51	83.16	13.36	109	99.57	99.39
15.4	101	94.69	92.69	14.36	110	99.97	99.92
16.4	110	99.02	97.41	-	-	-	-

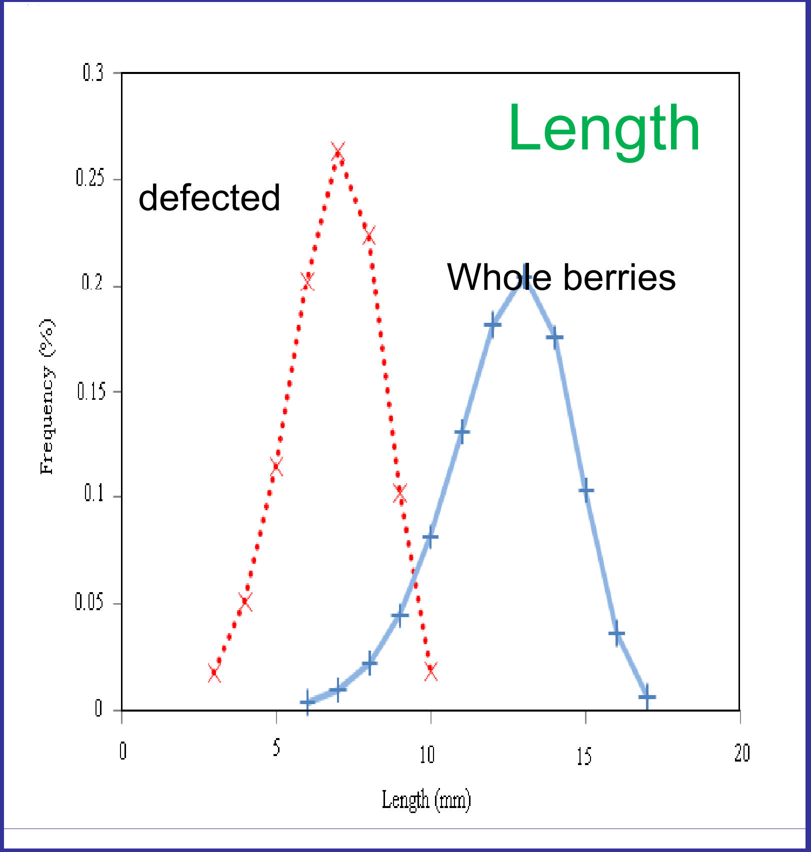
Results and discussion

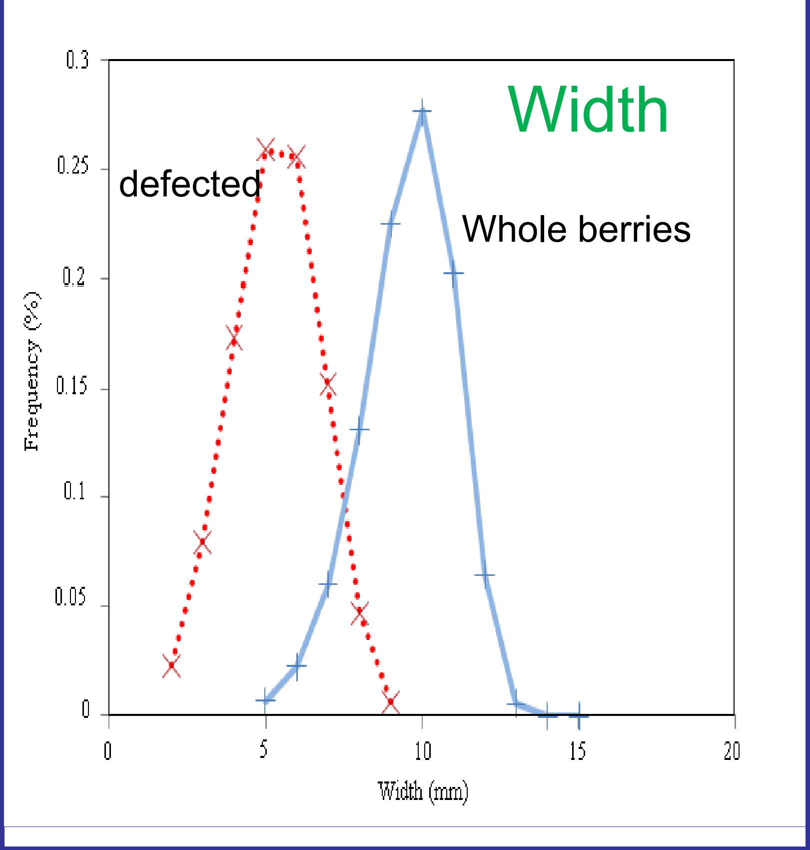
- CDF, for whole raisin berries at %16 (d.b).



Results and discussion

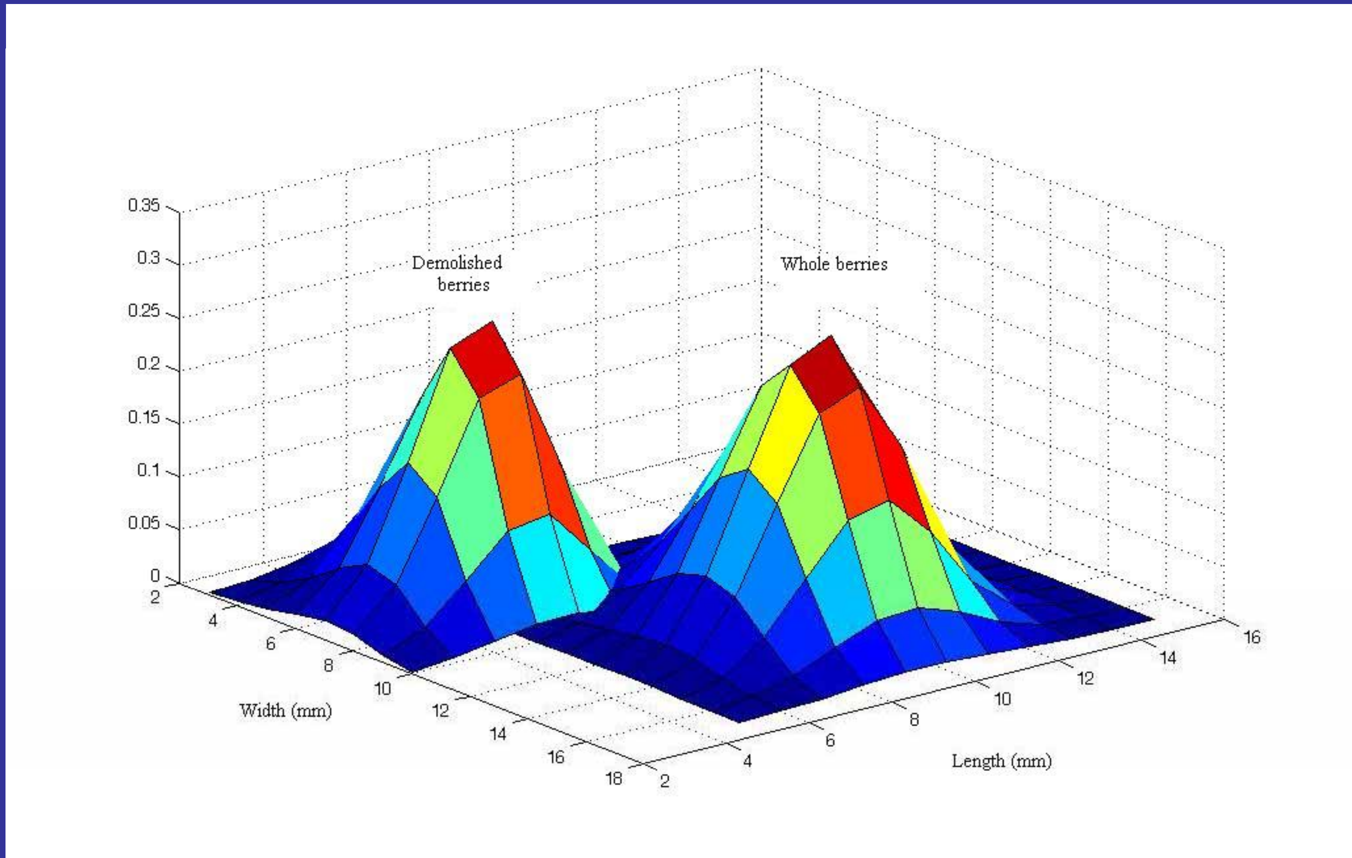
- Frequency distribution at %16 (d.b).





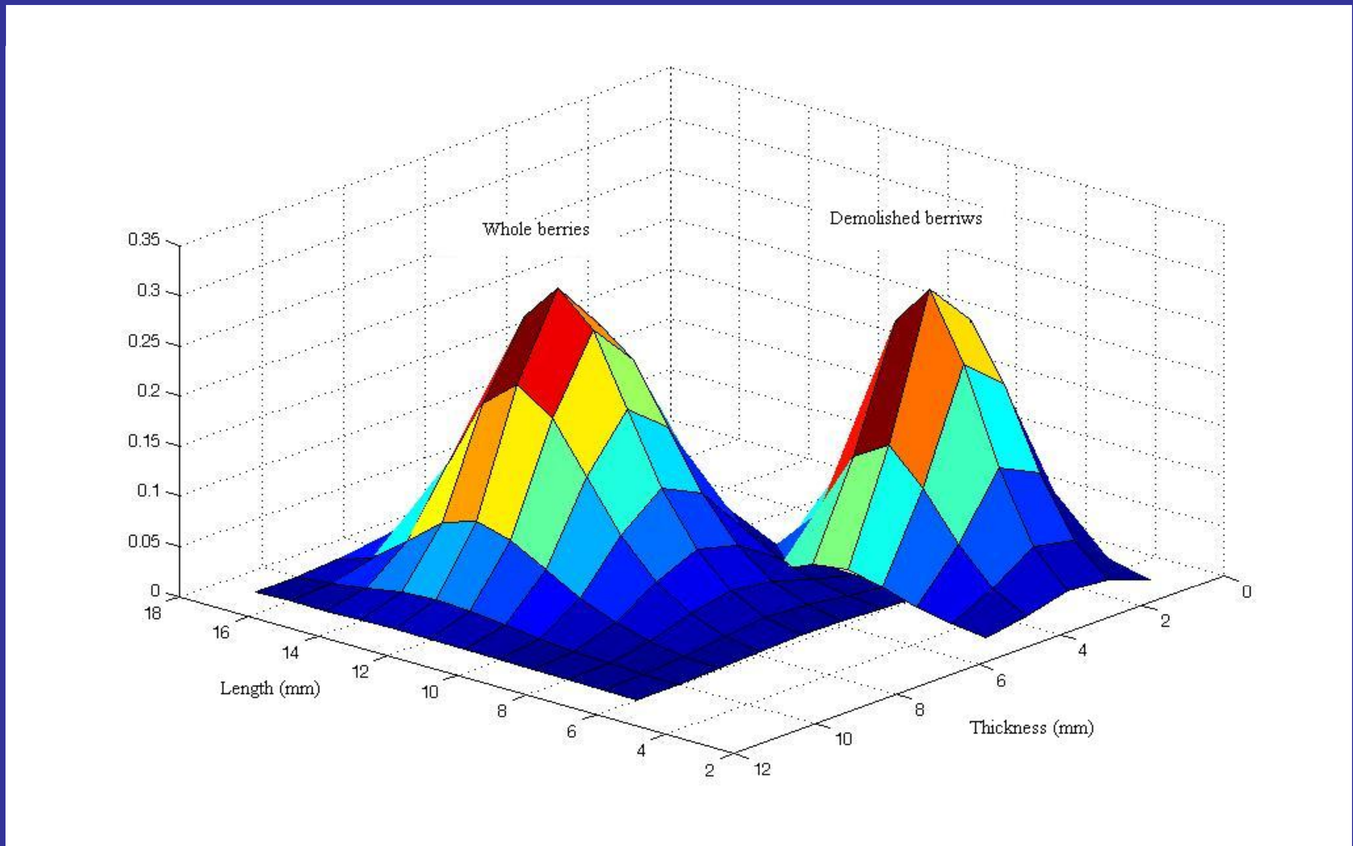
Results and discussion

- CDF, for whole and defected raisin berries at %16 (d.b).



❖ Results and discussion

- ❖ CDF, for whole and defected raisin berries at %16 (d.b).



Conclusion

- The results of this research are applicable for processing of raisins

- The overlap for different parameters of the whole and defected raisin berries helps to define a reasonable threshold line for different goals.

- The two-variable Weibull distribution function is the best computational tools for characterizing raisin berries.

- From economical point of view and possibilities either the aerodynamic or physical properties can be used for different process steps

Thank you

for your attention

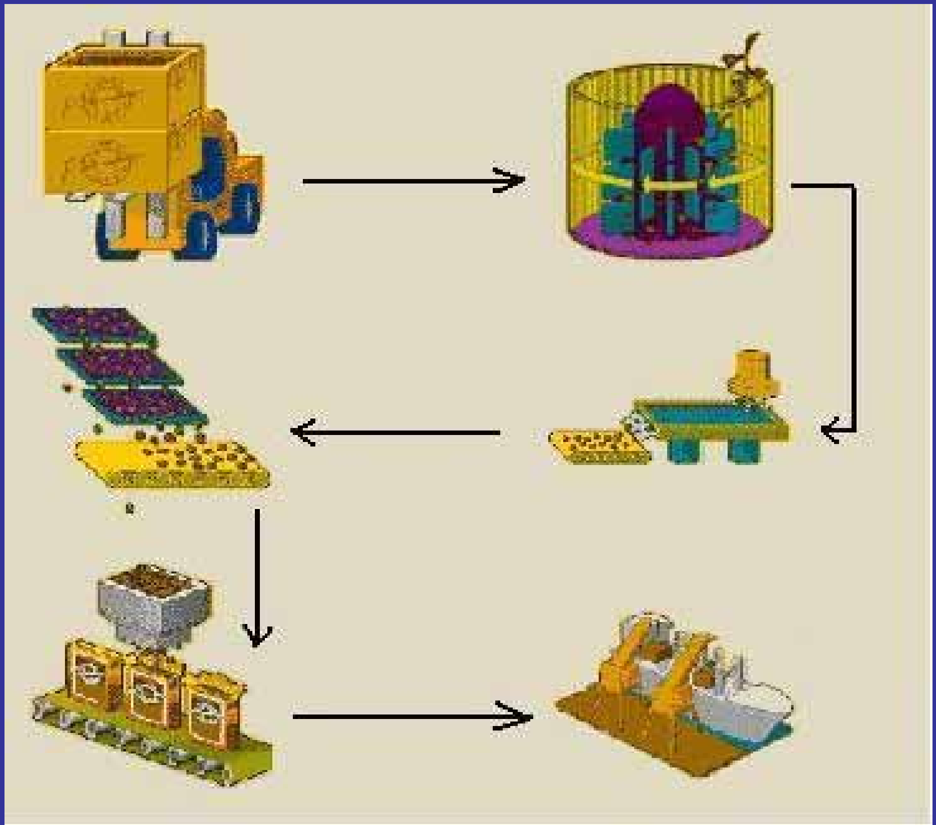
Introduction

• Turkey	1/3
• USA	15%
• Iran	15%
• Greece	8%
• Chili	7%

- 80% of whole

❖ Objective

- Manufacturing processes



Materials and Methods

- Effective parameters

❖ Sections