

# PREDICTION OF WHEAT AND FOUR QUALITY CONTROL PARAMETERS

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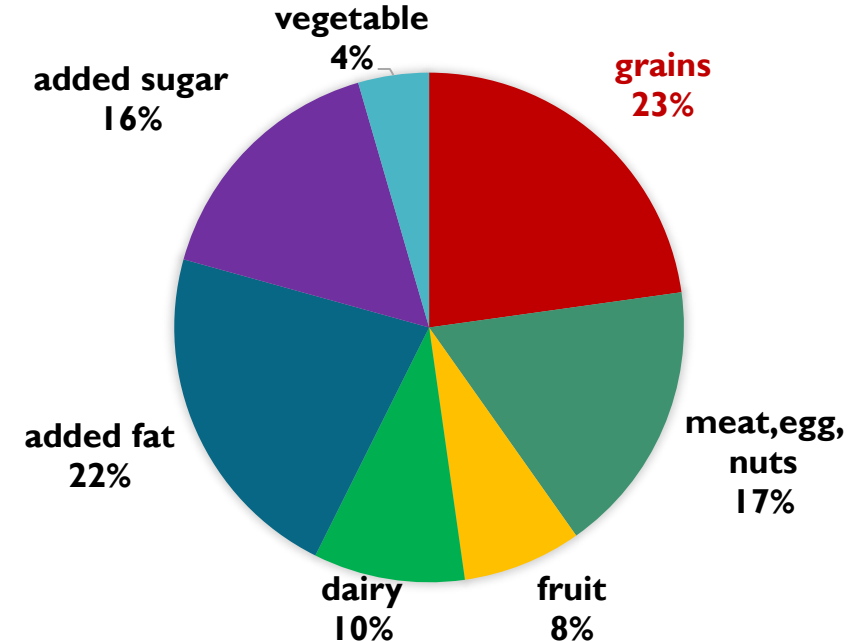
BASTAK INSTRUMENTS, TURKEY



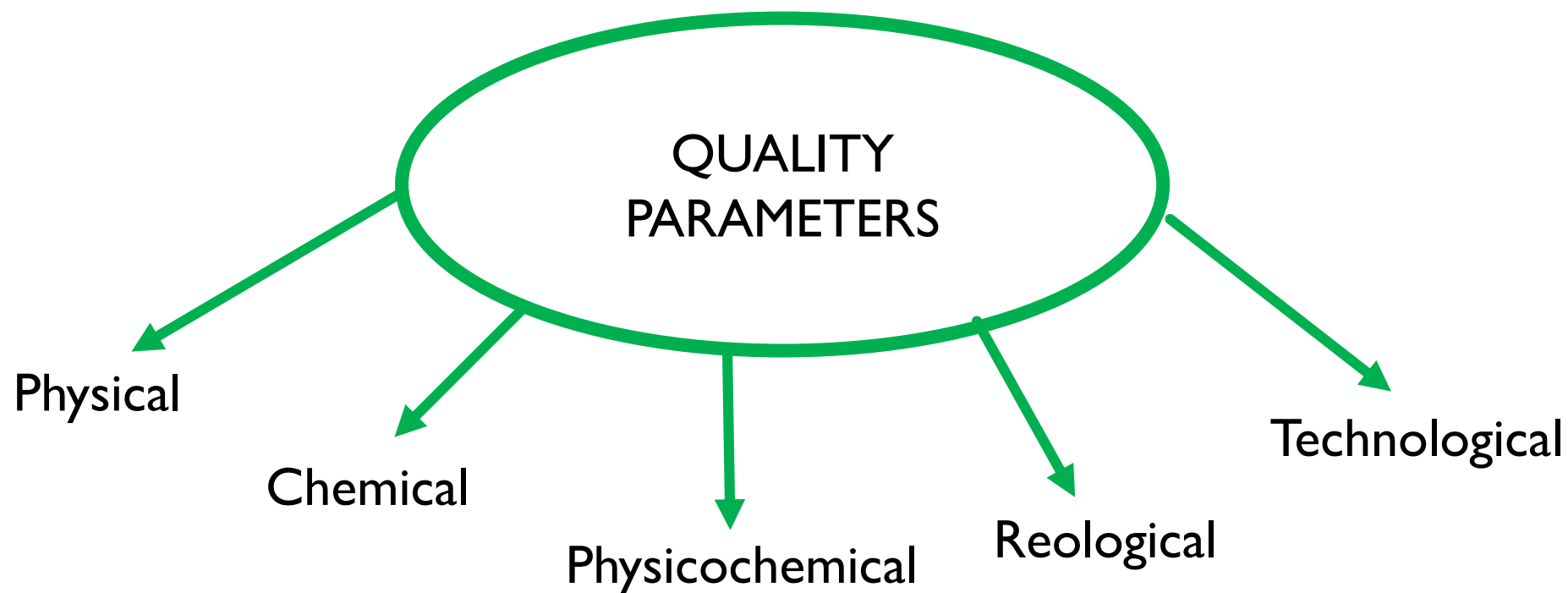
# GRAIN PRODUCTS AND DIET

- Grain products have the biggest part of human diet.
- Wheat is the one of the most important grains in daily human diet due to its nutritional value and easy-to-grow feature.
- Flour is used to obtain end-products such as bread, pasta, cake, biscuits depending on its quality.

DAILY HUMAN DIET CONSUMPTION  
TABLE



# QUALITY PARAMETERS OF WHEAT AND FLOUR



# BASTAK INSTRUMENTS



- Bastak Instruments company was established in 1999 at Ankara, starting with producing additives and quality control equipments about wheat and wheat flour.
- We are producing 36 kind of instruments and getting more instruments in every year with our R&D team.



# PHYSICAL PARAMETERS

- Hardness
  - Color (L, a, b)
  - Hectoliter
  - Sieve Analyses
- Physical parameters gives information about general appearance.
  - Color is also very important for durum wheat and end-product (pasta).



# PREPARATION OF SAMPLES

- Wheat must be milled to flour to carry out some analyses like protein, moisture, FN, sedimentation etc.
- Different type of mills (roller, crusher, hammer mill) can be used according to analysis.



# CHEMICAL PARAMETERS

- Moisture (%)
- Protein (%)
- Ash (%)
- They give information about chemical composition of wheat and flour.
- Price of wheat are decided according to moisture and protein content.
- While storage conditions of wheat are decided according to moisture content.





# PHYSICOCHEMICAL QUALITY PARAMETERS

- Gluten (%)
- Gluten Index (%)
- Dry Gluten (%)
- Falling Number (s)
- Sedimentation value
- Modified Sedimentation value





# RHEOLOGICAL QUALITY PARAMETERS

These instruments made dough from flour and they give detailed and important information about dough.

- Water Absorption
- Energy
- Stability
- Development time
- Degree of softening
- Resistance
- Extensibility



## FROM TRADITIONAL ANALYSIS TO NIR

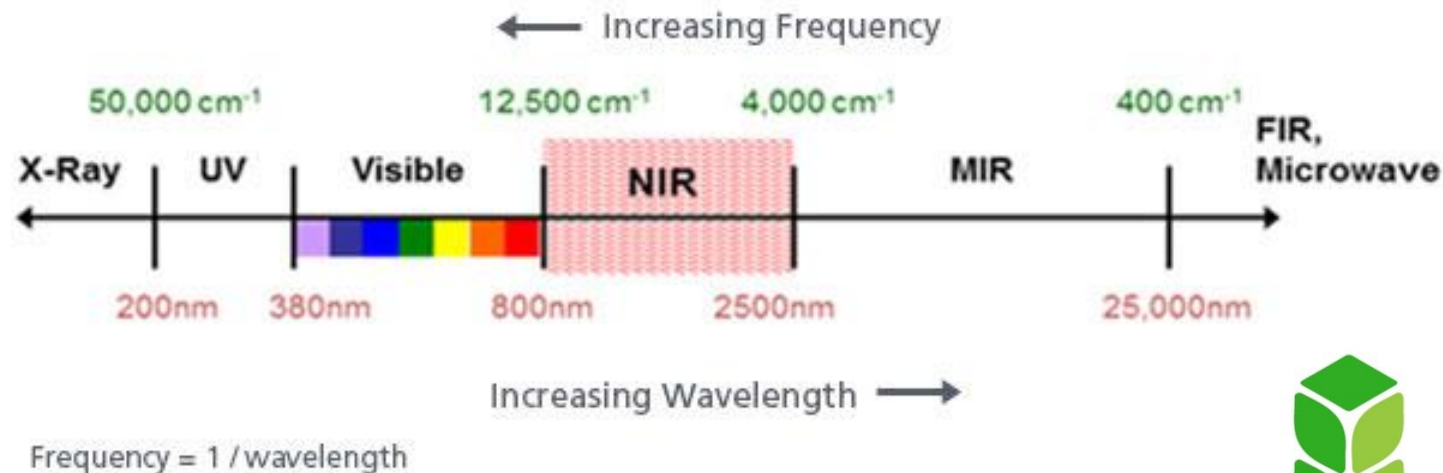
- These mentioned analyses are very important for determining the price, nutritional value, usability to end products, and many other important features of wheat.
- However, they have some disadvantages; such as taking long time, requiring experienced staff, usage of hazardous chemicals etc.
- New methods are started to use to eliminate these disadvantages. NIRS is the first and the most important one among them.

## COMPARISON OF TRADITIONAL ANALYSES AND NIR

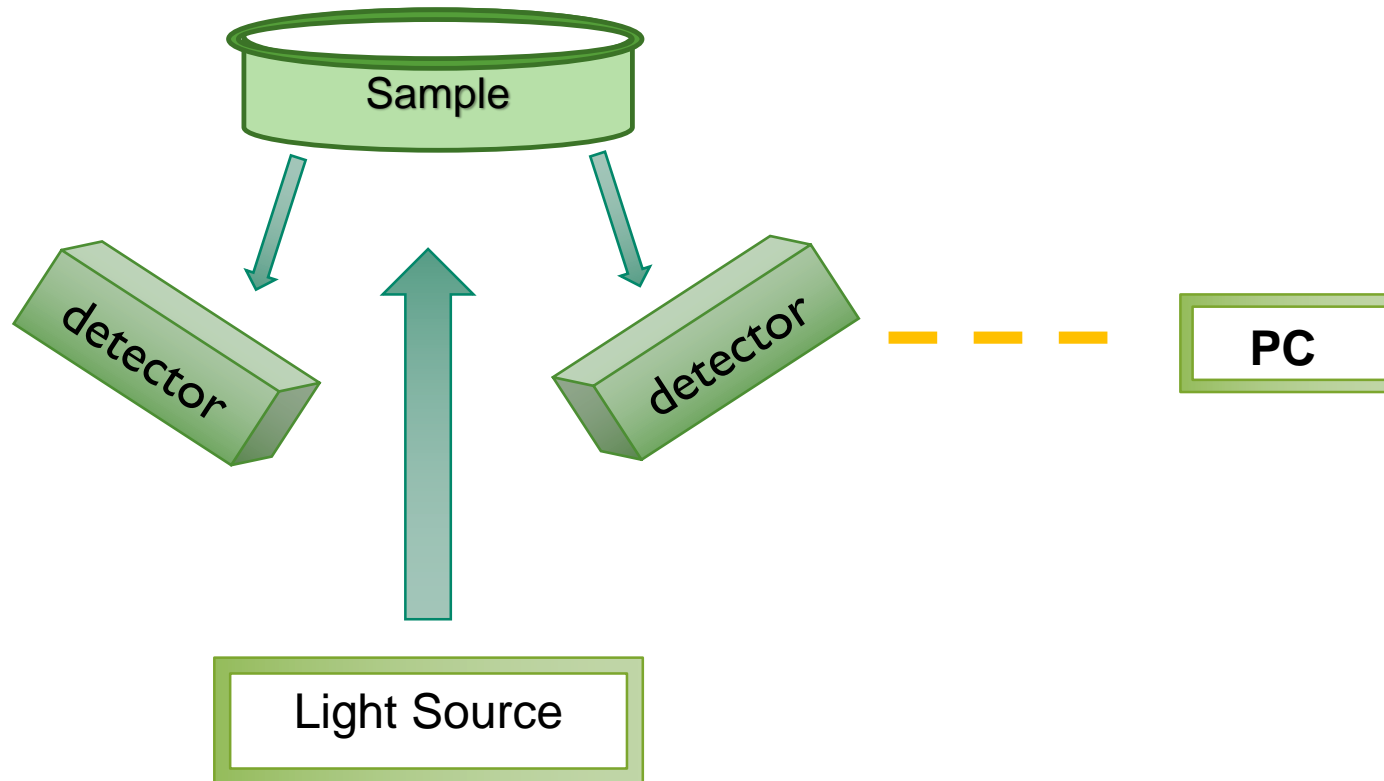
	Traditional method	NIR method
Experienced stuff	Need	No need
Rapid analyses	X	✓
Dangerous chemical usage	✓	X
Sample usage and reduction	✓	X
Sample preparation	✓	X
In-field analyses	X	✓
Several analyses at the same	X	✓
Consumables usage	✓	X

# NEAR INFRARED SPECTROSCOPY

- Near Infrared (NIR) lights were discovered by Herschel at 1800s.
- NIR spectroscopy is based on the absorption of electromagnetic radiation between 780-2500 nm.



# NIR SCHEME



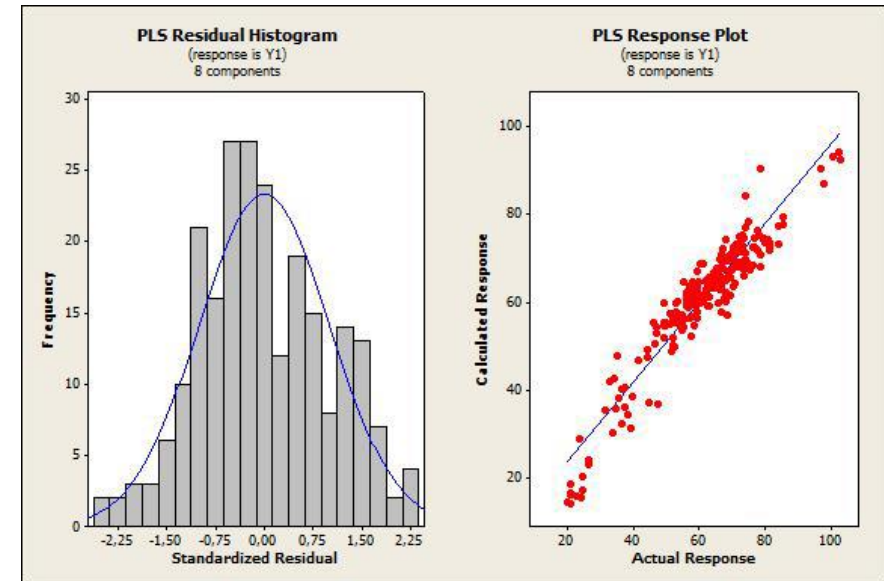
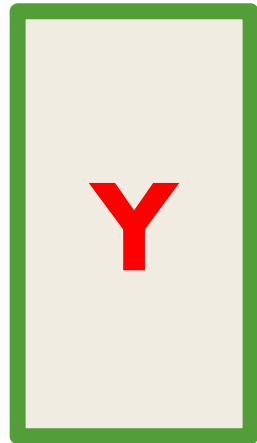
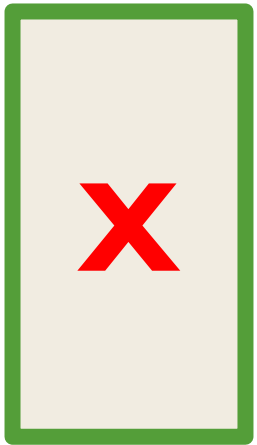
Light goes through optical way up to the sample. Some part of light is absorbed by sample and other part is reflected. That reflected part is determined by detectors and it can be seen at PC as absorption bands.

## RELATIONSHIP BETWEEN DATAS

- Reference analyses give results about wheat characteristics.
- Spectral data have the information about wheat characteristics.
- Chemometric techniques such as Partial Least Square (PLS) and mathematical methods such as Artificial Neural Network (ANN) are used to built a relationship between reference analysis and spectral data.

# PARTIAL LEAST SQUARES REGRESSION (PLSR)

- The aim of PLSR is build a **linear** relationship between spectral data (X) and reference data (Y).



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instruments



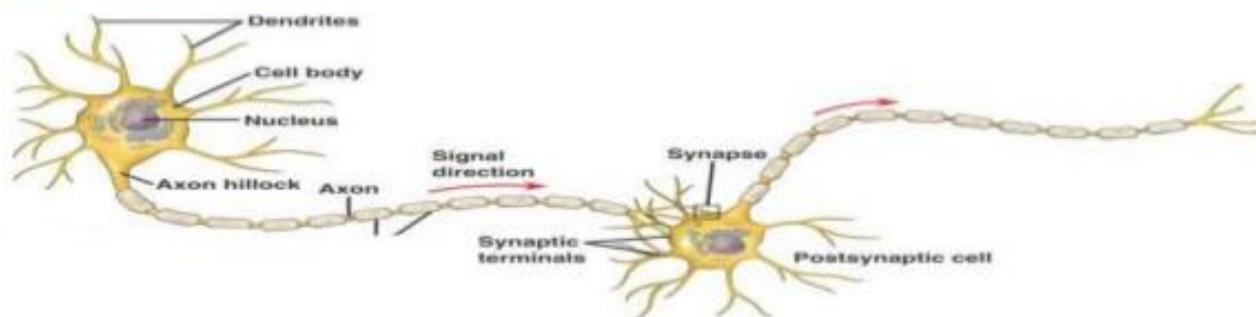
# ARTIFICIAL NEURAL NETWORK (ANN)

- Artificial neural network is a calculation model that imitate the learning mechanism of biological system like brain.
- The most important advantage of ANN is that have the ability to built a **nonlinear** relationship between spectral data (X) and reference data (Y).

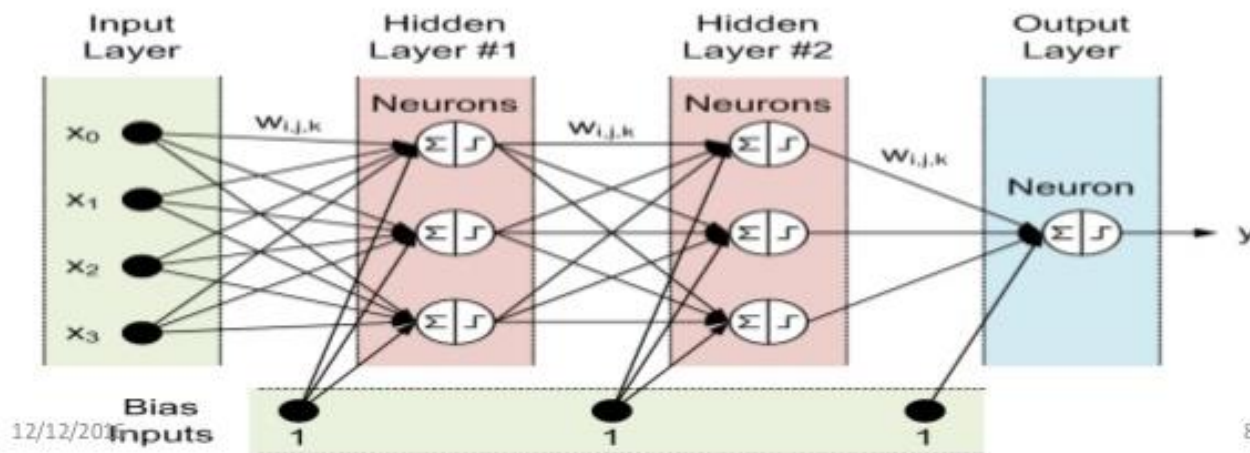


# ARTIFICIAL NEURAL NETWORK (ANN)

Biological neural network



Artificial neural network



- Once the neural network has been trained, it can be used on the entry variables to get the predictions.

## IMPORTANT POINTS

- Reference analyses must be carried out carefully.
- **The higher numbers** of samples means the **better prediction** ability of **calibration** models.

# METHOD

- Reference analyses were carried out.
- Spectral analyses were carried out by using NIR analyzer.
- Then we built a model by using chemometric tools.

Reference  
Analyses



NIR  
Analyses



Data  
Analyses

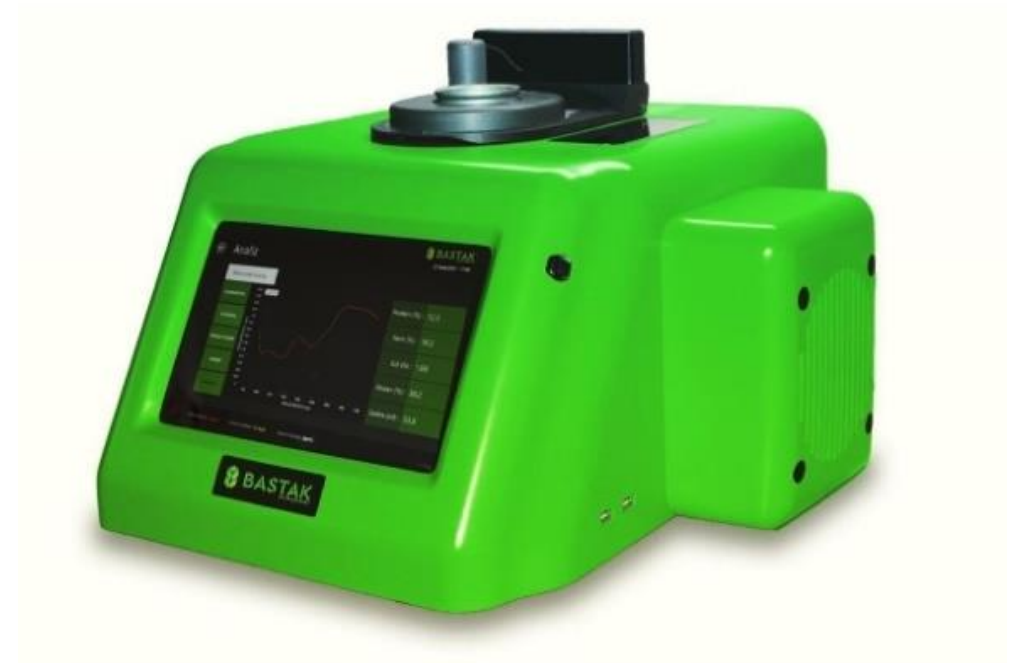


**MODELS**



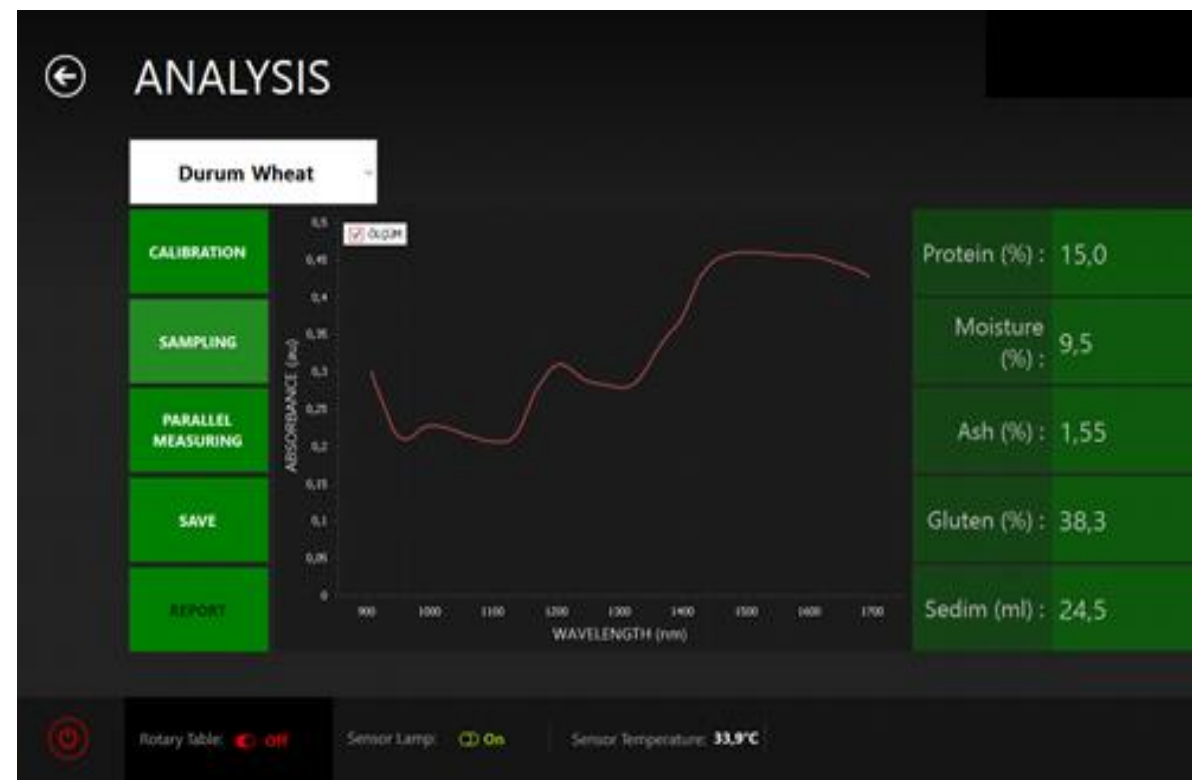
# BASTAK NIR ANALYSER DA-9500

- Working wavelength is between 908-1694 nm.
- Resolution is 8 nm.
- Analysis time is 20 seconds.
- Weight of instruments is 12 kg.
- Dimensions are 43 X 42 X 21 cm.



# BASTAK NIR ANALYSER DA-9500

- ✓ It can measure protein, ash, moisture, gluten content and sedimentation value.
- ✓ You can choose which sample you want to analyze like red wheat, white wheat, durum wheat and flour.
- ✓ It has easy to use software and touchscreen





# RED WHEAT

Protein Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.967	0.999	2.00	10.30	18.90
Validation	0.958	0.993	2.42	10.10	18.70
Moisture Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.985	0.999	1.21	7.10	18.40
Validation	0.948	0.994	2.42	7.20	17.40
Gluten Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.904	0.9975	4.25	19.20	46.80
Validation	0.860	10.105	5.63	20.40	46.90
Ash Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.802	0.999	3.03	1.32	2.00
Validation	0.710	0.999	5.27	1.32	2.21
Sedimentation Value	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.915	0.996	5.36	26	69.00
Validation	0.796	0.951	7.96	30	68.00



# WHITE WHEAT

Protein Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.978	1.000	1.64	10.00	19.00
Validation	0.962	0.993	2.10	10.40	18.20
Moisture Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.967	0.998	1.49	7.20	17.30
Validation	0.947	0.999	2.25	6.90	17.20
Gluten Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.978	0.999	1.99	22.50	44.10
Validation	0.618	1.004	6.96	21.30	46.20
Ash Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.952	0.999	2.50	1.29	2.17
Validation	0.796	0.978	4.48	1.22	1.76
Sedimentation Value	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.942	0.997	4.24	33.00	70.00
Validation	0.835	0.982	8.41	27.00	67.00

# DURUM WHEAT

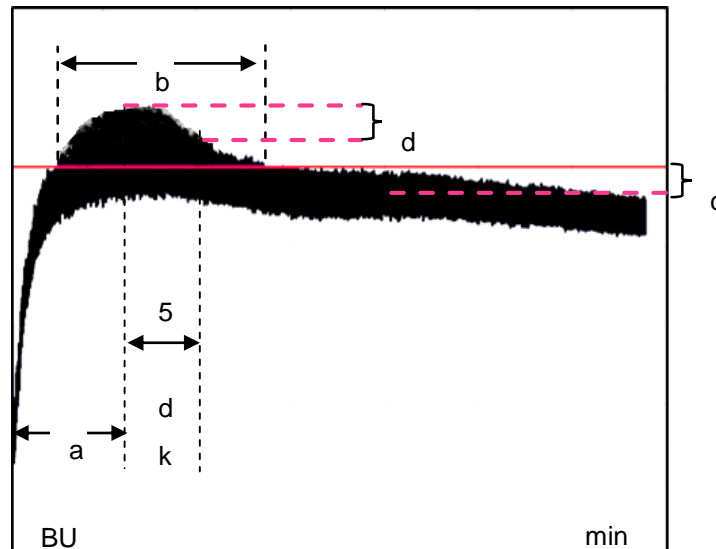
Protein Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.981	0.999	1.61	9.7	21.2
Validation	0.971	1.001	1.98	9.6	19.7
Moisture Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.982	0.999	1.19	7.9	18.5
Validation	0.973	0.994	1.55	8.1	16.9
Gluten Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.907	0.997	4.87	17.9	45.9
Validation	0.927	1.013	4.69	19.3	44.9
Ash Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.809	0.999	3.17	1.3	2.09
Validation	0.783	0.991	3.98	1.3	2.18
Sedimentation Value	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.769	0.988	10.14	8	39
Validation	0.826	0.971	9.77	8	38

# FLOUR

Protein Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.976	10.014	2.18	8.00	18.00
Validation	0.964	10.051	2.66	8.10	17.20
Moisture Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.957	10.003	0.97	10.90	15.50
Validation	0.902	0.999	1.38	11.0	14.00
Gluten Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.839	0.995	6.19	13.30	43
Validation	0.801	0.977	7.17	13.10	40
Ash Content (%)	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.852	10.084	8.21	0.39	1.07
Validation	0.825	0.980	7.13	0.40	1.04
Sedimentation Value	R <sup>2</sup>	Slope (y=ax)	% Average error	Min	Max
Calibration	0.872	0.991	8.76	19	70
Validation	0.829	1.004	7.74	18	60

# IN PROGRESS

- Hectoliter
- Water absorption level
- Fat
- Energy ...
- Barley
- Corn
- Other grains



# PORTABLE NIR ANALYZER FOR WHEAT

- It can be used in field.
- Protein and moisture content of wheat can be determined by using portable NIR analyzer.
- It makes analysis in 20 seconds.



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# ONLINE NIR ANALYZER FOR WHEAT AND FLOUR

- Online NIR analyzer can be used on the product flow line.
- Analysis parameters are sedimentation, protein, moisture, ash, gluten content etc.
- It has a wireless connection system.



# ONLINE NIR ANALYZER FOR WHEAT AND FLOUR



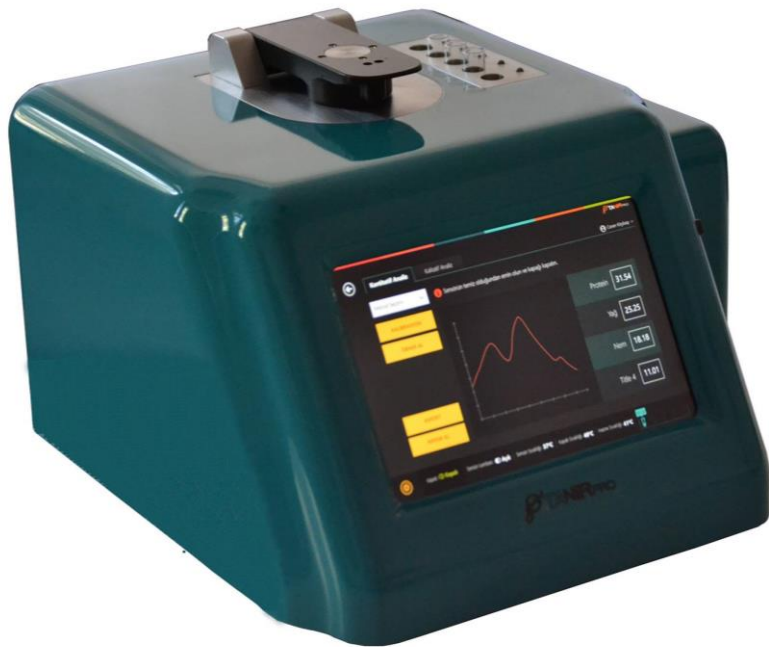
- It is easy to mount on the production line.
- Emergency intervention alarm is possible.
- It is designed for analysis of powder, grain, granules, pellets and similar products.
- It gives results every 10 minutes or time can be adjusted.



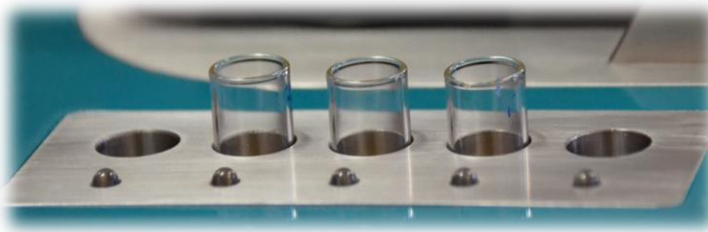
## OTHER PRODUCTS

- NIRS can be used on other products like wine, milk, meat, egg, oil etc.
- The calibration models can be adjusted according to requirements.

# NIR ANALYZER FOR LIQUID EGG



- NIRS technology is applicable not only grain but also egg.
- Parameters that can be predicted are dry matter, oil, brix and protein content.
- Analysis time is 20 sec.
- However, sample must be homogenized before spectral analysis.



# CONCLUSION

- As a result, NIRS is a very good tool to predict the quality parameters of wheat and wheat flour without harming samples or using any chemicals.

## However;

- It is not a primary method.
- It needs to be calibrated against reference methods.
- Optical path must be kept clean.
- Sampling must be done carefully.

# THANK YOU FOR LISTENING

## We welcome you on



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