Application Note
No. 797/2022

Fish industry application using NIR ProxiMate™

ProxiMate™ NIR up-view
Process control in the fish industry using NIR ProxiMate™

1. Introduction

The fish meal and oil industry is present on 5 continents and, among the 15 largest producers in the world, production exceeds 4,488 thousand tons per year. Both for export and for domestic consumption, the quality control for this industry ranges from the analysis of the raw material to the final product, be it fish meal or oil.
The primary analysis methodologies employed demand time and specialized personnel, with the analysis of raw materials occuring directly on the vessels, bringing danger to analysts when handling chemical reagents. The measurement of TVN (Total Volatile Nitrogen) in ground fish correlates closely to the freshness, which as the raw material of fishmeal, directly impacts final fishmeal product quality.
Once caught, fish are loaded from the fishing boat or vessel to a floating platform and stored in seawater. Ideally, when the floating platform reaches full capacity, the fish carcasses are pumped to the processing factory. However, in most cases the quality of the fish would deteriorate to an unacceptable level before the floating platform reaches full capacity.
ProxiMate™ is used to constantly measure and assess fish freshness (by periodic measurement of TVN). When the TVN level reaches a certain threshold, the fish carcasses are pumped to the processing factory, regardless of remaining floating platform capacity.
By constantly monitoring freshness, the company minimizes pumping costs whilst maximizing high quality product yield.
ProxiMate™ is also used within the industry to grade bags of fishmeal produced by the factory. Fishmeal is graded primarily by protein level. The difference between standard and high-quality fishmeal is a difference of only 1% protein but the financial impact is huge, with a difference in price of $1000 per tonne.

2. Equipment

- NIR ProxiMate™ up-view
- Petri dishes

3. Why ProxiMate™?

ProxiMate™ is ideally suited because:

Robustness:
When used on the floating platform, to monitor fish freshness, the ProxiMate™ is exposed to seawater and is constantly subjected to the motions of sea swell and waves. This harsh environment prevents the safe use of wet chemistry methods, such as those based on distillation and titration. Offering the highest IP69 protection rating, ProxiMate™ is ideally and uniquely suited to this measurement point. In the fishmeal plant QC laboratory, where the instrument is used to analyze and grade final fish meal, the environment is dusty and dirty. Fishmeal is greasy meaning that the laboratory area and instruments are difficult to keep clean.

Speed:
The speed of measurement, compared to alternative analysis methods provide a huge advantage in both locations. For example, it is impractical to monitor fish freshness in real time with other analysis techniques.

Regulatory Approval:
Working closely with the largest companies in the industry, Applications were rapidly developed and improved leading to approved method status with both the Peruvian Ministry for fishing and approved by the European Commission for import into the EU.

4. Applications

All products obtained in the fishmeal production process can be measured in the NIR. Below is the illustrated Production Flow. In red are the products in which calibrations are being developed using ProxiMate™.

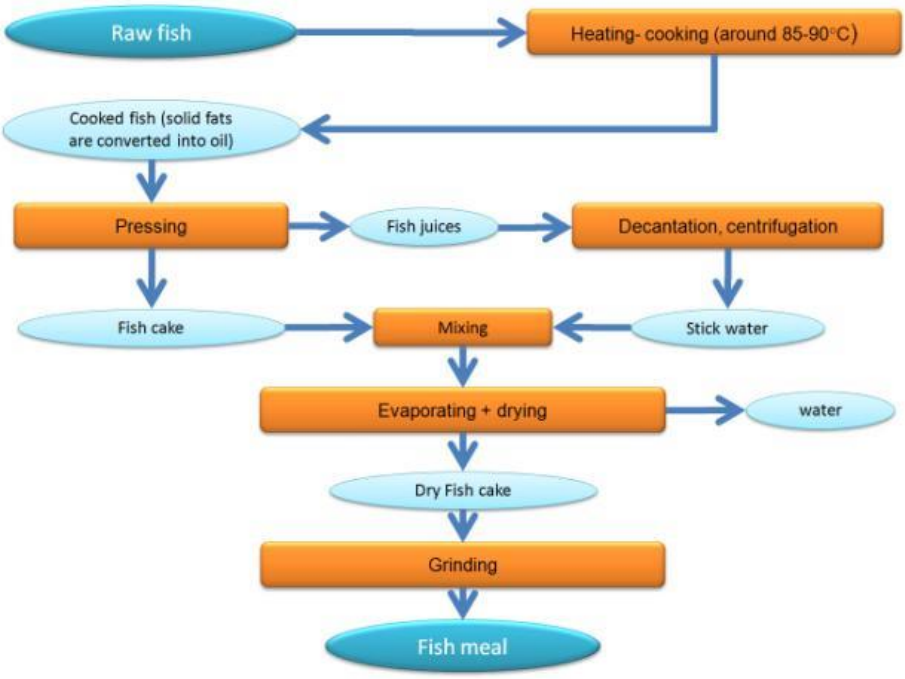

Figure 1: Fish meal; Credits: Valérie Heuzé, Gilles Tran / AFZ, https://www.feedipedia.org/node/208

For intermediate products and fish meal, there was no need for sample preparation. They are measured in the NIR as they are received from the process. In the case of raw material (Ground fish), there is a need to grind the fish for better homogeneity.

The calibration curves developed have the following performance information.

*Table 1: Parameter developed for final product **Fish Meal Application***

Parameter	R^2	Range	SEC	SEP
TVN (mg N2 / 100g)	0.77	63-232	8.85	8.91
Protein (%)	0.79	62-71	52	51
Moisture (%)	0.84	4.7-10.3	0.22	0.22
Histamine (ppm)	0.7	5.0 - 4898	343	343
Fat (%)	0.91	7.0 - 13	0.23	0.23
Chlorides (%)	0.52	1.8 – 6.9	0.38	0.39
Ash (%)	0.69	14-19	0.43	0.43
Acidity (%)	0.64	4.0 - 14	0.84	0.84

*Table 2: Parameters developed for Fishmeal **Press Cake** Application*

Parameter	R^2	Range	SEC	SEP
Fat (%)	0.86	2.9-5.20	0.13	0.13
Moisture (%)	0.88	37-44	0.5	0.55

*Table 3. Parameter developed on **Rework Fish Cake** (following removal of fish oil)*

Parameter	R^2	Range	SEC	SEP
Fat (%)	0.98	0.93-10.5	0.28	0.29
Moisture (%)	0.99	57-81	0.5	0.7

*Table 4: Parameters developed for **Ground Fish** (Raw material)*

Parameter	R^2	Range	SEC	SEP
TVN (mg N2 / 100g)	0.62	15-38	2.27	2.77
Ash (%)	0.71	3.5-4.35	0.1	0.08
Chlorides (%)	0.47	0.3-1.20	0.11	0.11
Fat (%)	0.98	1.1-12.1	0.21	0.21
Moisture (%)	0.91	66.7-78.35	0.45	0.52

*Table 5: Parameters developed for **Dry Fish Cake** Application (raw cake after initial press)*

Parameter	R^2	Range	SEC	SEP
Fat (%)	0.94	0.51-10.5	0.45	0.54
Moisture (%)	0.97	67-81	0.38	0.46

*Table 6: Parameter developed for the **Intermediate Fish cake Application** (water plus raw press cake)*

Parameter	R^2	Range	SEC	SEP
Fat (%)	0.89	2.3-5.40	0.12	0.14
Moisture (%)	0.96	50-67	0.55	0.61

5. Additional Information

In addition to the products listed above, other products can be measured such as fish oil where parameters such as acidity and moisture can be accurately predicted by ProxiMate™.
NIR-Online sensors for real-time process control can also be used at the same analysis points shown above.

6. Conclusion

The use of the BUCHI ProxiMate™ NIR instrument in the fish meal industry increases the number of daily analysis performed allowing quality control of the raw material in real time, guaranteeing accurate information for decision making.
The calibrations obtained demonstrate the quality of the measurements and the approval by regulatory agencies attest that using NIR in this segment has great advantages: savings in consumables, greater analytical security by lowering potential chemical exposure to analysts and offering greater repeatability of results and time savings.