Characterization of raw milk of ruminants by means of Fluorescence spectroscopy

Vanya Plachkova[**], Alexandra Zhelyazkova[†], Latchezar Avramov[†], Chavdar Zemyarski[*] and Petar Petrov[*]

[*]Technical University of Sofia, Dept. Optoelectronics & Lasers, Plovdiv Bulgaria;
[†]Emil Djakov Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Abstract- Four different samples have been tested by fluorescence spectroscopy. Three of the tested samples are of different ruminants: goat, sheep and cow. The fourth sample is a mixture of cow's milk in several different breeds of cow. It has been found that the most appropriate excitation wavelength fluorescence method for investigate of milk in ruminants is 255 nm. This is due to the fact that only at this wavelength there is little difference in emission wavelengths between goat and sheep milk. Emission wavelengths of small ruminants vary considerably in emission wavelengths with that of the cow, which belongs to a class in cattle. In this case, an essential point in the fluorescence spectroscopy with respect to testing cow's milk is that the milk taken from a cow breed differs in wavelength of fluorescence with that which is a mixture of several breeds. This fact means that the method of fluorescence spectroscopy is suitable for determining the quality of milk from the selected breeds, if that is the desire of farmers. We consider that an efficient analysis of the raw milk of ruminants separately proven method of classical fluorescence. With analysis by synchronous fluorescence not observed shift in emission wavelengths in comparison between the goat and sheep milk.

Index Terms- fluorescence , wavelengths, ruminants, raw milk, spectroscopy, emission wavelengths

I. INTRODUCTION

Lactiferous animals are divided into class Mammals. They are the highest achievement of biological evolution on Earth. The yield of milk starts 6000 years ago, and even earlier. The most common milk-producing animal is the cow, which live on all continents and in nearly all countries. The sheep is extremely important for the Mediterranean countries and large parts of Africa and Asia. The number of sheep in the world exceeds one million. Sheep and goat milk are a source of cheap and at the same time biologically valuable protein. For several years now analysis of milk products started the use of fluorescence spectroscopy. This method is fast and efficient with a previously prepared data library. Fluorescence spectroscopy does not require additional supplies in the analysis as other validated chemical tests for certification of agricultural production.In recent years more and more yogurts, represent a mixture example of cow's and sheep's milk or sheep's and goat's milk or cow's and goat's milk.

Therefore, much attention is paid for tests using fluorescence spectroscopy of mixed milks.

II. MATERIAL AND METODS

A. Fluorescence measurements.

Fluorescence spectra were recorded using a Spectrometer - FluoroLog3 - TCSPC - Horiba Scientific. The Steady-state of Spectrometer is Broadband 450-W xenon arc lamp from UV to near-IR. The Resolution of FluoroLog3 is 0.2 nm. Of all the modern time-domain methods, including boxcar integration and streak cameras, TCSPC has by far the best dynamic range (Figure 1). Fixed-wavelength "Plug and Play" interchangeable NanoLED pulsed laser-diodes and LEDs. Wavelengths of 280, 340, 375, 405, 440, 473, 635, 650, 785 and 830 nm are available for laser-diodes. 370, 455, 465, 485, 560, 590, 605, 625 for LEDs.

Standard optical pulse durations are <200 ps (<100ps typical) for laser-diodes, <1.5 ns for LEDs.

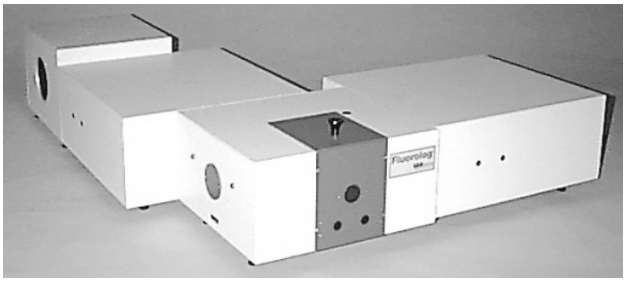

Figure 1. Spectrometer - FluoroLog3 - TCSPC - Horiba.

B. Excitation and emission spectra by classical fluorescence spectra.

For all studies samples of milk (cow milk, mixture cow milk, goat milk and sheep milk) the excitation wavelength is 255 nm This is due to the fact that it only has a small difference in the peaks of fluorescence between goat and sheep milk. Records were made at the emission wavelengths set to: 343 nm for raw cow milk, 357 nm for sheep milk, 355 nm for goat milk and 366 nm for mixture cow milk. Samples of small ruminants vary considerably in the emission wavelengths with that of the cow, which belongs to a class in cattle. Consideration was given to a certain fluorescence spectroscopy test of mixed milks.

The proportion of samples was 1:1, it is not currently performed fluorescence assay at various percentages of one or another type of milk. The excitation wavelength for all studied samples of mixture milk is 255 nm. The records with the emission wavelengths are set at: sheep+cow milk - 364 nm, sheep+goat milk - 360 nm, goat+cow milk - 354 nm.

C. *Synchronous fluorescence spectra*

Synchronous fluorescence spectra were collected in the 250–550 nm excitation wavelength angle using offsets of 80 nm ($\Delta\lambda$ = 80 nm) between excitation and emission monochromators. Spectra were recorded in triplicate for each condition using different samples.

III. RESULTS AND SIDCUSIONS

As an efficient research of the raw milk of ruminants separately *proven* method of classical fluorescence. In the method of the synchronous fluorescence was not observed shift in the emission wavelengths in the treatment of goat, cow and sheep milk. For this reason, it has not been applied graphics of synchronous fluorescence, but only classical fluorescence. Figure 2 clearly shows the difference in emission wavelength between cow and sheep milk. Similar is the case where a comparison is made between goat and cow milk, therefore the second graphics are not shown.

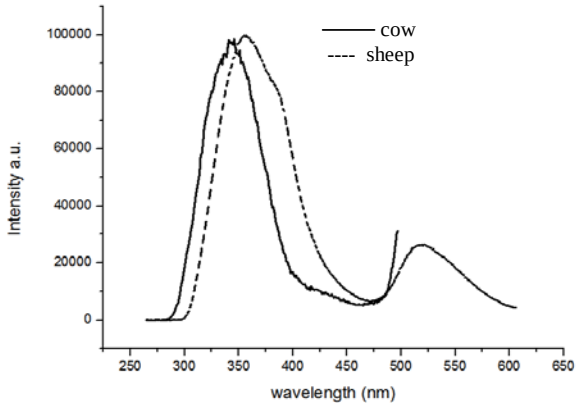

Figure 2. Difference between emission wavelengths for cow and sheep milk, excitation spectra is set to 255 nm.

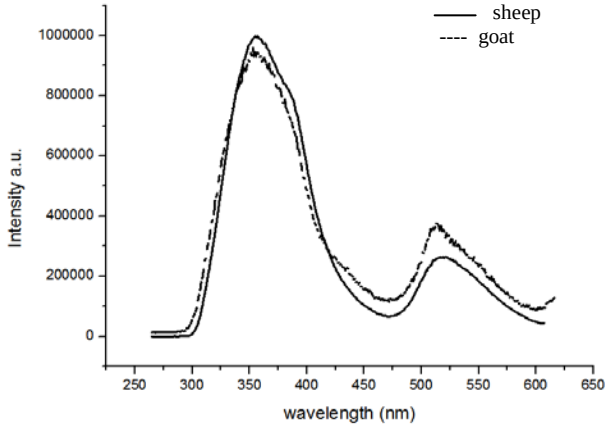

Figure 3. Difference between emission wavelengths for goat and sheep milk, excitation spectra is set to 255 nm.

Figure 3 observed little difference between *emission wavelengths* of goat and sheep milk by classical fluorescence. On the samples were applied various *excitation spectra*, but only at 255 nm it was seen slight shift from the above samples. Near *emission wavelength* is due to the fact that the milk of healthy sheeps and goats are similar in composition. Samples of small ruminants vary considerably in the emission wavelengths with that of the cow, which belongs to a class in cattle. This can be seen clearly in Figure 2. Substantial results are shown on Fig.4. In fluorescence spectroscopy with respect to testing cow milk is that the milk taken from a cow breed differs by emission wavelength with that which is a mixture of several breeds. This means that the method of fluorescence spectroscopy is suitable for determining the quality of milk from a selected breed.

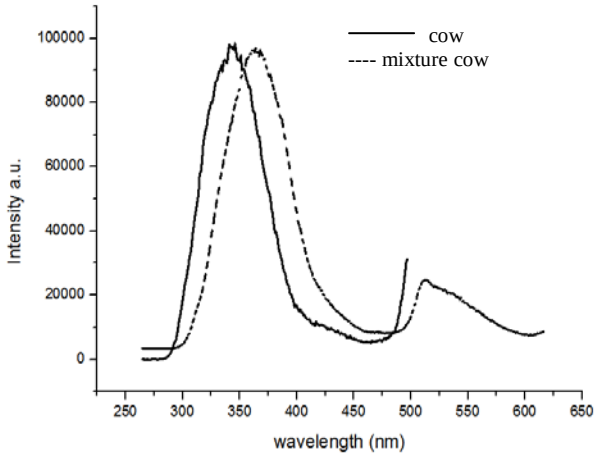

Figure 4. Difference between emission wavelengths for cow and cows breed mixture milk, excitation spectra is set to 255 nm.

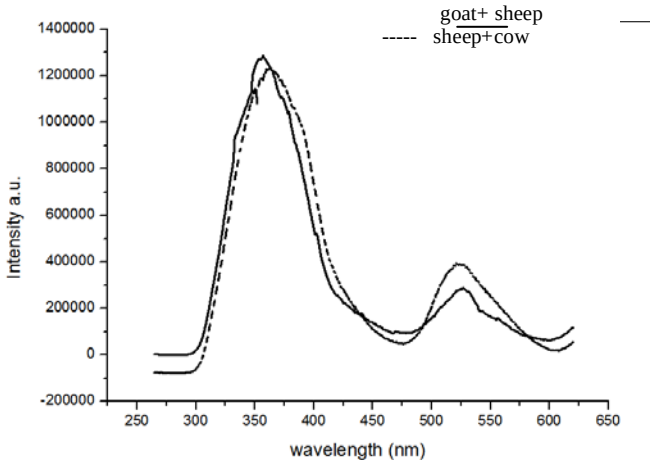

Figure 5. Difference between emission wavelengths for goat+sheep and cow+sheep milk, excitation spectra is set to 255 nm.

Considerable attention was given to the examination by fluorescence spectroscopy of mixed milks presented on Figure 5 and Figure 6. Mixes represent a mixture of milk from large ruminant (cow) and retail (respectively goat and sheep) ratio of

the samples was 1:1. Currently fluorescence spectroscopy isn't tested at different rates of one or other type of milk. It turned out that the shift by emission wavelength at various mixes is not so great, as the shift between milk from one cow breed and that from several breeds.

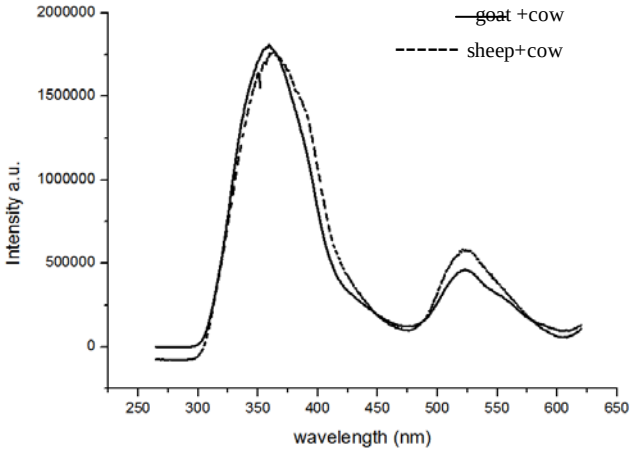

Figure 6. Difference between emission wavelengths for goat+cow and cow+sheep milk mixtures, excitation spectra is set to 255 nm.

This means that by mixing equal percentage of milk from large and small ruminants is obtained more similar performance than mixing the milk from different breeds of cattle.

The fact that mixes are with close wavelengths of fluorescence due to the fact that such indicators have small fluctuations in the wavelength of fluorescence is that because they have close indicators of goat's and sheep's milk than cow. By mixing with cow's milk sheep or goat mix gives such indicators as only sheep or goat milk separately are with similar indicators.

IV. CONCLUSIONS

Optimal wavelength for fluorescence analysis of pure milk from ruminant animals is 255 nm. Suitable for analysis is the method of the classical fluorescence. The fluorescence spectroscopy is suitable for analysis of milk for both selected and mixed animals. The fluorescence method is suitable for detection if milk from a cow breed or mix of several breeds (this would represent the interests of farmers who selected their breeds).

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AUTHORS

First Author – Vanya Plachkova – M.S. photonics, Technical University of Sofia, Branch Plovdiv, Dept. Optoelectronics & Lasers vania_plachkova@abv.bg
Second Author – Alexandra Zhelyazkova – Physicist, Emil Djakov Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria alexandra_jivkova@abv.bg
Third Author – Latchezar Avramov Prof. Dr.Sc. Emil Djakov Institute of Electronics, Bulgarian Academy of Sciences, Sofia, Bulgaria latchezar.avramov@gmail.com
Fourth Author – Chavdar Zemyarski – veterinarian, Technical University of Sofia, Branch Plovdiv, Dept. Optoelectronics & Lasers, ch_zemyarski@abv.bg
Fifth Author – Petar Petrov physicist engineer, Technical University of Sofia, Branch Plovdiv, Dept. Optoelectronics & Lasers, peter_petrov85@abv.bg

Correspondence Author – Vanya Plachkova – M.S. photonics, Technical University of Sofia, Branch Plovdiv, Dept. Optoelectronics & Lasers, 61, blvd. St.Petersbourg. 4000 Plovdiv vania_plachkova@abv.bg +359896786450