Detection of frauds of certified chicken cuts by NIR analysis

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Introduction

Certified products of specific quality aim to meet higher standards than the minimum statutory requirements. Our research is focused on the "broiler", a product characterised by a variety of seals of approval and quality labels in Europe. The production rules set out in the specifications affect the quality of the end product. Slow-growing chicken strains and a low energy density diet are used to reach a commercial slaughtering weigth at an age of at least 81 days. This parameter is probably the most critical factor to obtain a characteristic quality of the meat[1–3] but it has a indisputable impact on the costs of the certified products (the usual slaughtering age of chickens coming from intensive systems and using fast-growing strains is ± 42 days). Such quality products require specific guarantees if they are to be credible. To achieve this, reliable analytical control systems have to be set up to verify their conformity with the specific standards and also their labelling.

Discriminant models based on the analyses of chicken meat by NIR were previously developed to distinguish slow-growing chickens from fast-growing ones.[4] The study was afterwards extended to a larger set of animals and takes account of special labelling according to European regulation 91/1538/CEE.[5] An animal experiment was set up to test the ability of our discrimination models to detect frauds concerning as well the type of strain (use of a fast-growing strain) as the diet (high-energy density diet).

Material and methods

Animal experiment

Four groups of seven male chickens were bred until they reached the required weight for marketing and were slaugthered regardless of age. The animals used in the experiment belang to the slow-growing chickens strain ISA 657 or the fast-growing one Cobb 500. Two groups were fed with a "farmer quality" feed and the two other groups with a "standard quality" feed. The characteristics of the four experimental groups are summerized in Table 1. The carcasses were then cut up as in previous experiments.[4]

NIR samples analysis

Three types of cut pieces corresponding to commercial products were analysed: legs with skin, breasts without skin and carcasses with skin. So, for each individual, there were two samples of each type; and for each type of sample, the total effective is 14 samples. All the spectra were collected in triplicate. The spectral data treatment was performed on the average spectra.

Table 1. Characteristics of the four experimental groups of chickens.

	Chicken strains	Type of feed	Slaughtering age
Group 1 Industrial control	Cobb 500	Standard quality	43 days
Group 2 Industrial fraudulent	Cobb 500 (*)	Farmer quality	50 days
Group 3 Certified fraudulent	ISA 657	Standard quality (*)	68 days
Group 4 Certified control	ISA 657	Farmer quality	79 days

(*) Criteria in contradiction with the production rules of the certified production

Spectrometers

Two spectrometers were used to collect the spectral data: an NIRSystems 6500 (Foss-NIRSystems Inc., Silver Spring, USA) in direct contact analysis (DCA) configuration and a Perten DA 7000 (Perten Instruments Inc., Chatham, USA).

Software

All manipulations and processing of the spectra were carried out with the software WinISI II (Infrasoft International, Port Matilda, USA). The «Discriminate groups» option, based on partial least square regression (PLS2), was used to assign the samples to the "Certified chickens" group or the "Industrial chickens" one.

Discriminant models

Statistical models of discrimination were developed with the spectral data of 140 chickens (70 certified slow-growing chickens and 70 fast-growing chickens from intensive systems) coming from various origins and including the 14 chickens of the control groups.

Results and discussion

Performances of NIR discriminant models

The discriminant models developed previously were able to identify cuts coming from chickens bred according to rules sets of certified productions such as Label Rouge. Their specific standards impose the use of a slow-growing strain, a low energy diet and a slaugthering age of at least 81 days. The individuals of groups 2 and 3 are in contradiction with these criteria. The fraud will be detected if the statistical models classify the samples as belonging to "industrial" chickens.

Table 2 shows the results based on measurments acquired with NIRSystems 6500 spectrometer. All the samples of groups 1 and 4 (control groups) were correctly classified. The samples of Group 2 were mainly (92.9% to 100%) detected as fraudulent. The results obtained with the samples of Group 3 were lower (57.1% to 85.7%).

The results obtained with the Perten DA 7000 spectral data are described in Table 3. With this spectrometer, one breast sample of group 1 was wrongly classified. The results are similar excepted for the analyses of breasts samples of Group 2.

Table 2. Percentages of samples identified as fraudulent by discriminant models developed with NIRSystems 6500 spectral datas.

Type of samples	Group	n	% of samples detected as fraudulent
Legs	Group 2	14	92.9 %
	Group 3	14	57.1 %
Breasts	Group 2	14	92.9 %
	Group 3	14	85.7 %
Carcasses	Group 2	14	100 %
	Group 3	14	71.4 %
Mean		84	83.3 %

Table 3. Percentages of samples identified as fraudulent by discriminant models developed with Perten DA 7000 spectral datas.

Type of samples	Group	n	% of samples detected as fraudulent
Legs	Group 2	14	92.9 %
	Group 3	14	57.1 %
Breasts	Group 2	14	57.1 %
	Group 3	14	85.7 %
Carcasses	Group 2	14	100 %
	Group 3	14	71.4 %
Mean		84	77.4 %

Discussion of the results

- The majority of samples were detected as fraudulent and would not be classified as certified products. Globally, 83.3% of the samples analysed with the NIRSystems 6500 and 77.4% of the ones analysed with the Perten DA 7000 were identified as fraudulent.Excepted in the case of the breasts analysed with the Perten DA 7000, a fraud concerning the use of a fast-growing chicken strain (Group 2) is more frequently detected (> 90%) than a diet in contradiction with the production rules (Group 3: 57–85 %).
- As in previous results, the performances of models built with the NIRS6500 are higher than these obtained with the Perten DA 7000. The characteristics of the two spectrometers (wavelength range and spectral resolution) and the sample presentation could influence the results.

Conclusions and further prospects

The use of a fast-growing strain or a high-energy diet are two realistic type of fraud to decrease the costs of production. The slaugthering age of the Certified control group (Group 4) is significantly higher: 11 days with Group 3 and 29 days with Group 2. The individuals of the Group 4 were slaugthered at 79 days (two days before the limit imposed by the rules set). For the control of the experiment, they were not free range and this can explain a higher growth rate.

Based on the limited results presented here, NIR shows promising performances to detect such types of frauds and could be used as a screening analytical control technique of certified chicken products. Nevertheless, NIR remains a statistical method. So, in parallel with NIR, our laboratory develops also genetic fingerprints able to distinguish slow- from fast-chicken strains.[6] The

combination of the two techniques could be very usefull to the certification's control of chicken products.

Acknowledgements

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