Effect of Gamma irradiation and Storage Time on the Sprouting of Cocoyam Corms

Absract

Colocasia esculenta (NCe 001 and NCe 011) and Xanthosoma sagittifolium (NXs 001 and NXs 002) Nigeria cultivar were subjected to gamma irradiation at doses of 20, 40, 80, 120 and 150Gy and stored. The effect of radiation dose and storage time on the sprouting vigour these cocoyam varieties was studied. Statistical analysis of the experimental results was conducted. The results of the studyS indicated that the control samples sprouted than the irradiated samples during storage. The results also showed that there was a dose dependent decrease in the irradiated samples with 150Gy samples having the least number of sprouted corms. A significant difference between the control samples and irradiated samples at p≤ 0.05 was observed in the study. The result of the study thus showed that gamma irradiation can be used as a processing method to improve on the storability of cocoyam by inhibiting sprouting of cocoyam corms.

Key words: sprouted, irradiated, radiation dose, storage time

Introduction

Cocoyam a member of the *Araceae* family is one of the oldest crops grown for its edible corms and leaves, and as an ornamental plant (Alabi *et al.*, 2019). It is widely grown in tropical and sub-tropical countries (Samaa, 2019). In Nigeria, cocoyam has remained a very minor crop produced by farmers in selected locations. Despite being grown on a smaller scale cocoyam are known to have a high content of tiny, easily digestible, starch grains ranging in content between 22 and 40%, making it a good source of starch (Ejoh *et al.*, 2013). Cocoyam has nutritional advantages over other root and tuber crops. It has more crude protein than root and other tubers and its contents of calcium, phosphorus, vitamins A and B are reasonable (Owusu-Darko *et al.*, 2014). All these are lost nutrition because of the ease of sprouting during storage. Sprouting is one of the avenues of high physiological losses. Stored cocoyam usually sprouts and starts normal growth within four (4) weeks (NRCRI, 2010). After harvest about 50% loss has been reported after two months and 95% after five months as a result of sprouting. Sprouted cocoyam seedlings are poor quality planting materials because their vigour is reduced at the time of planting (Ejoh *et al.*, 2013). The consequence is a reduction in total yield. Traditionally, famers apply ashes from burnt woods to inhibit sprouting but this method is not effective in reducing postharvest loss due to sprouting. The economic importance of cocoyam as a food material there is being limited by non application of improved postharvest technologies such as radiation processing to minimize sprouting (Falade and Okafor, 2015).

Food irradiation is a postharvest technology that bringing food and food product into contact with radiations. These radiations have the ability to remove electrons bonded in an atom and molecule with their high energy making them become electrically charged and are thus known as ionising radiations (Zanardi *et al.*, 2018). The function of food irradiation is to control insect infestation and the numbers of pathogenic or spoilage microorganisms. It also helps to arrest or reduce ripening in fresh fruits and vegetables; sprouting in tubers and germination that occurs in bulbs (Madu *et al.* 2020). Therefore, this study aims to examine the effect of gamma irradiation

and storage time on the sprouting vigour of at using RSM to develop models, which can be employed for predicting the proximate and Vitamin composition of irradiated Cocoyam corms.

Materials and methods

The four cocoyam varieties used in this study were NXs 001 and NXs 002 of the *Xanthosoma sagittifolium* species and NCe 001 and NCe 011 of the *Colocasia esculenta* species and cultivar. The corms were supplied by the Cocoyam Programme of the National Root Crops Research Institute (NRCRI), Umudike, Abia State, Nigeria.

Forty-two kilogrammes (42kg) each of fresh and healthy corms of the four cocoyam varieties were sorted. The 42kg samples of corms were divided into six different groups, one group served as the control which was analysed immediately after harvest to determine the acridity content. The other five groups were packaged in polyethylene bags of 2 mm thickness and labelled accordingly. Each package containing 7kg of corms was treated with Gamma irradiation using five different doses of 20Gy, 40Gy, 80Gy, 120Gy and 150Gy. The absorbed doses were confirmed using Alanine dosimeters (Bruker Biospin USA (Billerica MA), Lot T030901. The irradiated cocoyam corms were marked for easy identification based on the dose of gamma irradiation they received and observed in an open shed at ambient temperature for seven months (28 weeks). The corms were carefully examined every week for the appearance of fresh shoots to indicate sprouting, weights and records were taken for the number of sprouted corms.

Results and Discussions

The results of effect of gamma irradiation on the sprouting of the four varieties of cocoyam after 28 weeks of storage are shown in Figure 1 – 4. It shows the means of irradiated cocoyam corms that sprouted during storage. Figures 1 – 4 showed that as the storage period increased, the number of sprouted corms increased. It can be seen from the results in Figures 1 – 4 that more of the control samples sprouted than the irradiated samples during storage. The results also showed that samples irradiated at 150Gy had the least number of sprouted of the cocoyam corms. A close look at the results in Figure 1 – 4 also revealed that as the dosage of gamma irradiation increased, the rate of cocoyam sprouting during storage decreased. Figure 5, shows that *Colocasia esculenta* (NCe 001 and NCe 011) varieties sprouted more than *Xanthosoma sagittifolium* (NXs 001 and NXs 002) varieties during storage.

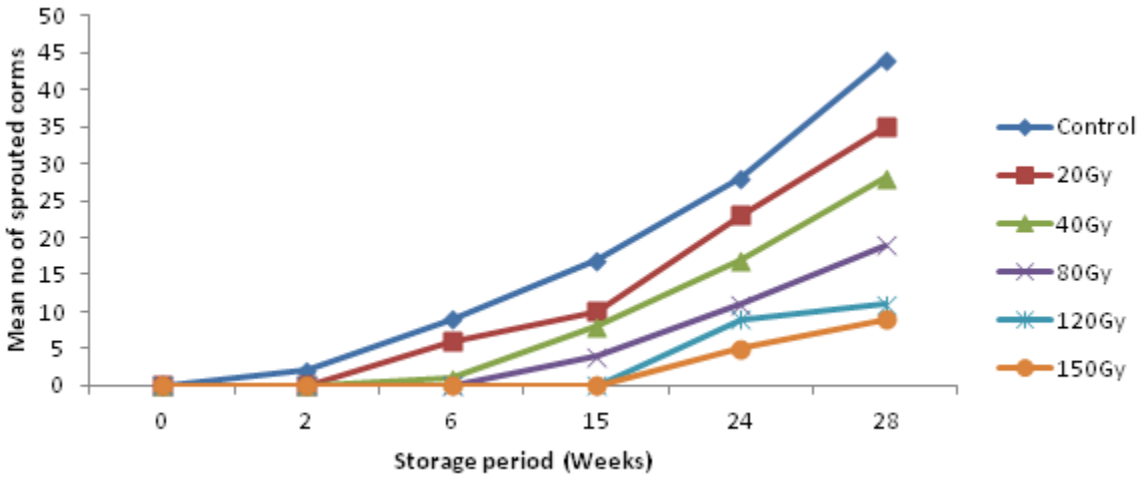

Figure 1: Mean number of sprouted NCe 001 corms irradiated at different doses

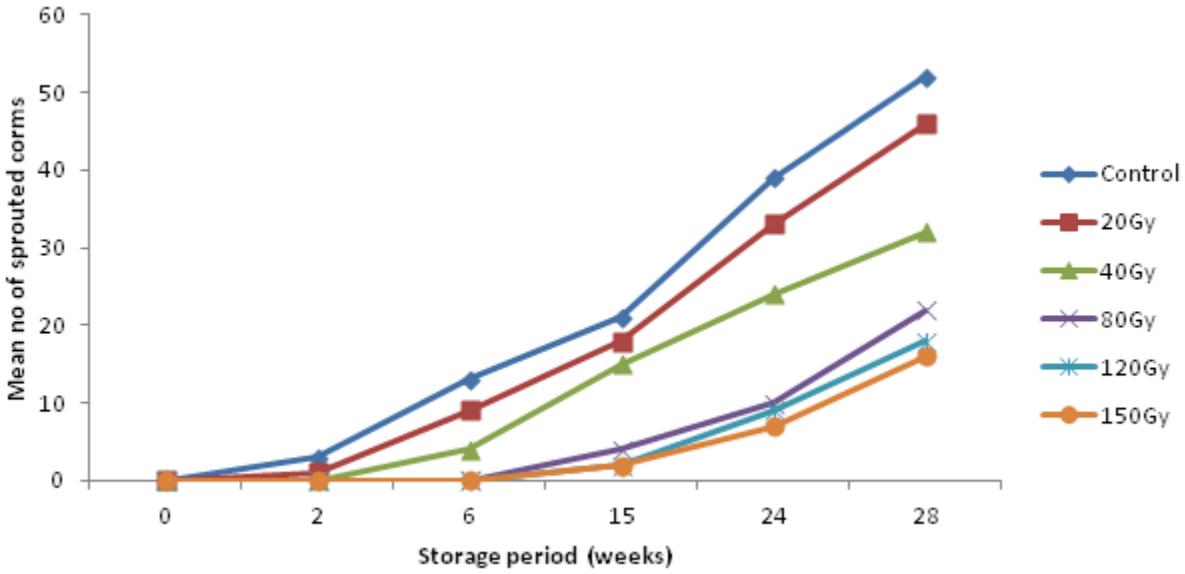

Figure 2: Mean number of sprouted NCe 011 corms irradiated at different doses

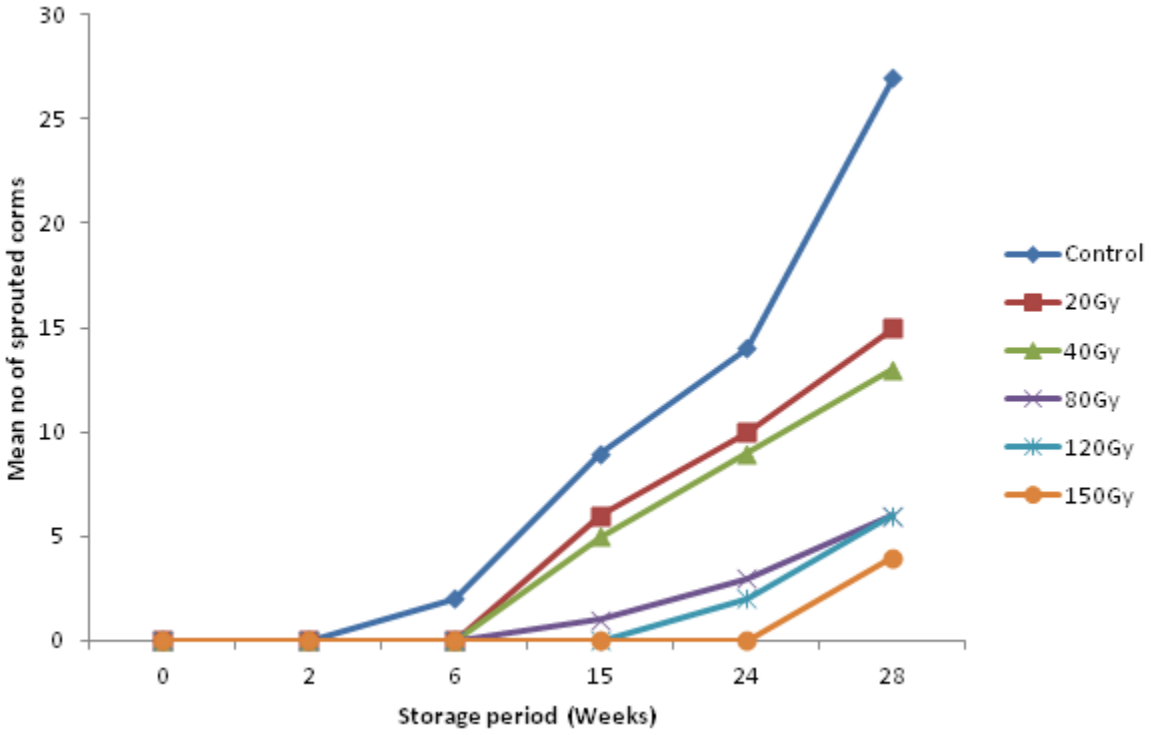

Figure 3: Mean number of sprouted NXs 001 corms irradiated at different doses

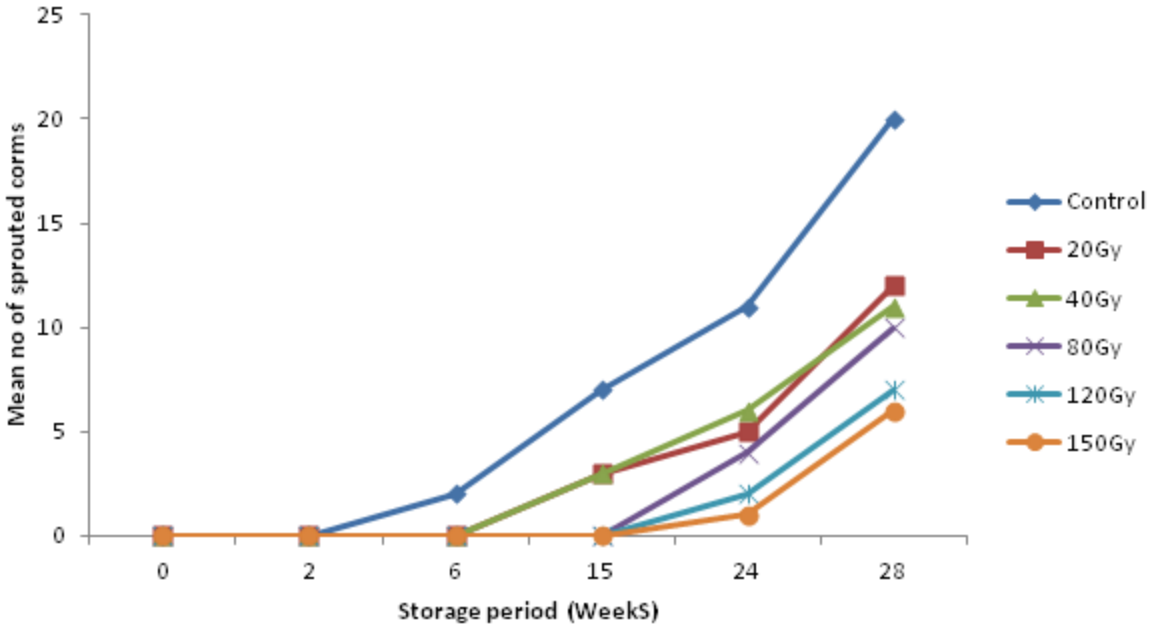

Figure 4: Mean number of sprouted NXs 002 corms irradiated at different doses

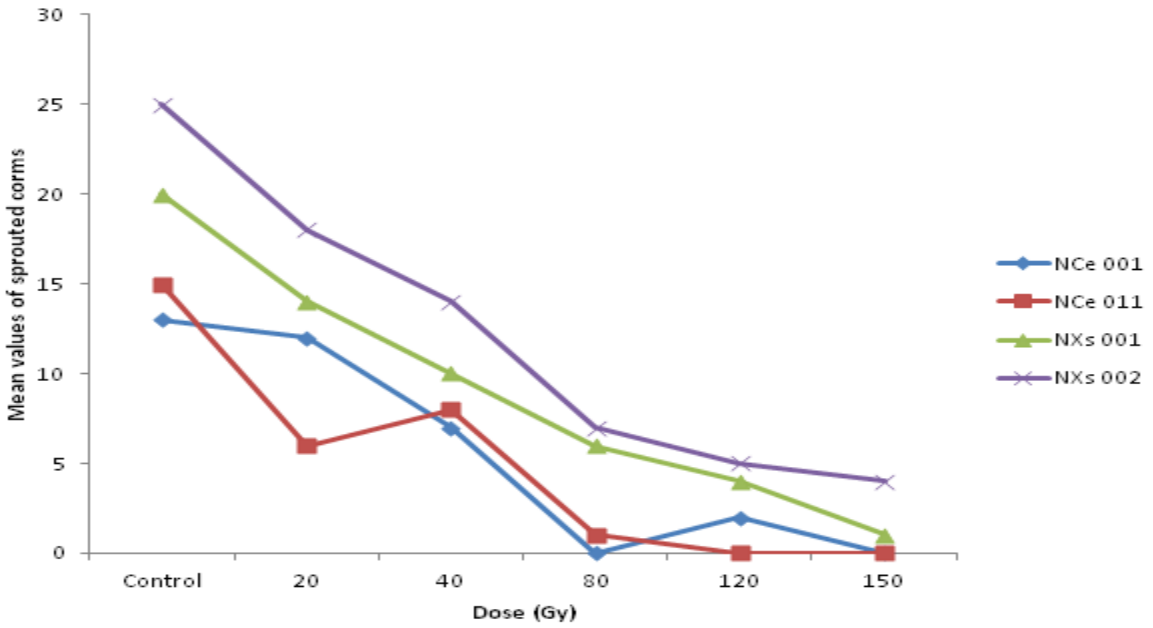

Figure 5: Mean values for effect of dose on sprouting of cocoyam corms irradiated at different doses

The statistical analysis of variance (ANOVA) for sprouting is presented in Table 1.The no significant difference terms were identified at $p \leq 0.05$. Table 1 indicates that there was a significant difference between the control samples and irradiated samples at $p \leq 0.05$ from the

model term *p*-value. Table 1 also presents that the interaction of dosage and storage (0.131) as well as storage and variety (0.900) had no significant differences at $p \leq 0.05$. But the interaction between dose and variety (0.010) had a significant difference at $p \leq 0.05$.

Table 1: Analysis of Variance for Sprouting

Source	DF	SS	MS	F-Value	P-Value
Model	14	428.910	30.636	6.26	0.000*
Linear	5	283.289	56.658	11.58	0.000*
D	1	201.030	201.030	41.09	0.000*
ST	1	23.950	23.950	4.90	0.040*
V	3	70.913	23.638	4.83	0.012*
Square	2	91.468	45.734	9.35	0.002*
D*D	1	40.698	40.698	8.32	0.010*
ST*ST	1	3.163	3.163	0.65	0.432**
2-Way Interaction	7	90.019	12.860	2.63	0.047*
D*ST	1	12.250	12.250	2.50	0.131**
D*V	3	75.000	25.000	5.11	0.010*
ST*V	3	2.838	0.946	0.19	0.900**
Error	28	88.060	3.145		
Total	67	516.970			

D = Dose (Gy); ST = Storage (weeks); V= Variety; *significant difference ($p < 0.05$); **no significant difference ($p < 0.05$); DF (Degree of Freedom) = n – 1 (n = sample size); SS = Sum of Squares; MS (Mean of Squares) = SS ÷ DF

Table 2 presents the statistical regression coefficients obtained for is presented in Table 3. The results from Table 2 indicated that dosage had the greatest effect on NXs 001(4.31) while storage had the greatest effect on NCe 001 (1.301). The effect of dosage and storage had no significant difference (0.131) at $p \leq 0.05$. The results in Table 2 indicated that the two-way interaction of dosage and storage was significant ($p \leq 0.05$). The study noted that dosage had a negative effect on NCe 001, while storage had negative effect on NCe 011 and NXs 001. Overall, dosage had an inverse relationship with sprouting as its effect on sprouting of cocoyam corms was negative. The effect of dosage and length of storage had little or no effect on the decay of NXs 002; hence it was removed from the result.

Table 2: Regression Coefficients for Sprouting

Term	Effect	Coef	SE Coef	T-Value	P-Value
Constant		1.25	1.07	1.17	0.257**
D	-8.321	-4.161	0.649	-6.41	0.000*
ST	2.545	1.272	0.575	2.21	0.040*
V					
NCe 011	-1.010	-0.505	0.677	-0.75	0.465**
NCe 001	4.896	2.448	0.657	3.73	0.002*
NXs 001	-2.626	-1.313	0.677	-1.94	0.068**
D*D	7.67	3.83	1.33	2.88	0.010*
ST*ST	-1.86	-0.93	1.16	-0.80	0.432**
D*ST	-3.83	-1.91	1.21	-1.58	0.131**

D*V					
NCe 011	2.00	1.00	1.08	0.92	0.367**
NCe 001	-8.30	-4.15	1.08	-3.84	0.001*
NXs 001	4.31	2.16	1.08	2.00	0.061**
ST*V					
NCe 011	-0.080	-0.040	0.941	-0.04	0.966**
NCe 001	1.301	0.651	0.885	0.74	0.472**
NXs 001	-0.651	-0.326	0.941	-0.35	0.734**

D = Dose (Gy); ST = Storage (weeks); V= Variety; *significant difference ($p < 0.05$); **no significant difference ($p < 0.05$).

When cocoyam sprouts in storage, it utilises stored food to support the sprouting. The result is increase in metabolic activity which leads to increase in respiration and loss of quality (Alabi *et al.,* 2019). Before the onset of sprouting, root, tubers and corms are in dormant phase. During dormancy, the endogenous metabolic rate of roots, tubers and corms is at minimum and therefore the dry matter losses are correspondingly reduced leading to constant respiration rate (Aniekwe, 2015). The rate of metabolism is controlled by sprout regulators such as nucleic acid, nucleotide, hormonal synthesising system (Kalu *et al*. 2019). Feng *et al*. (2016) further reported that these sprout-regulators are disrupted by the energy of agitation associated with gamma irradiation. These disruption delays the rate of sprouting. The results obtained in this study are thus a consequence of the disruption of the sprout-regulators. The results in the study obtained agreed with the findings of Adeyanju *et al. (*2019) for *Colocasia species* and Amadi *et al.* (2018) for *Xanthosoma species*.

Conclusion

Irradiation treatment is among the few available technologies to replace chemicals due to their carcinogenic and mutagenic properties. The result of the study shows that the dose of gamma irradiation had significant and negative effect on the number of sprouted cocoyam which implied that increased in irradiation dose resulted in decreased number of sprouted cocoyam. The application of gamma irradiation to tuber and root crops has the potential to reduce sprouting.

References

Adeyanju, J., Babarinde, G., Abioye, A., Olajire, A., Bolarinwa, D., (2019). Cocoyam processing: food uses and industrial benefits. *International Journal of Scientific and Engineering Research, Vol 1, 9*, 1658-1663

Alabi, A.O., Awotunde, J.M., Adekunle, A.A., and Adeoye, A.S., (2019). Approaches for Improving Cocoyam Production and Utilization Among Rural Farmers in Ogun and Oyo State, Nigeria. *J of Biol, Agric and Healthcare, (9)4*: 20-27.

Amadi, G.I., Achonwa, C.C., Ukwu, P.C. and Okoli, I.C. (2018). Physicochemical characteristics of Xanthosoma mafafa tuber meal subjected to palm bunch ash solution treatment. Proc.

43rd Annual Conference of the Nigerian Society for Animal Production, March 18th – 22nd 2018, FUT Owerri. Pp: 1386- 1388.

Aniekwe, L. (2015). Improving food security with cocoyam production by the smallholder female farmers in Ebonyi State, Southeastern Nigeria. *Journal of Biology, Agriculture and Healthcare*, *5*, 15–22

Ejoh, S.I., Obatolu, V.A.,, Olanipekun, O.T., and Farinde, E.O., (2013). Extending the use of an underutilised tuber I: Physicochemical and pasting properties of cocoyam (Xanthosoma sagittifolium) flour and its suitability for making biscuits. *Africa J of Food Sci. (7):*264-273.

Falade, K.O., and Okafor, C.A., (2015). Physical, functional, and pasting properties of flours from corms of two Cocoyam (Colocasia esculenta and Xanthosoma sagittifolium) cultivars. *J Food SciTechnol (52)6*: 3440–3448

Feng, X., Moon, S.H., Lee, H.Y., and Ahn, D.U., (2016). Effect of irradiation on the degradation of nucleotides in Turkey meat. *Lebensmittel-Wissenschaft&Technologie*, *73*, 88–94.

Kalu, E.O., Ani, J. and Nweke, C.J. (2019). Effect of differently processed cocoyam (Colocasia esculenta (L.) Schott) inflorescence on hematological and histological parameters of albino rats. *Biotechnology: An Indian Journal*, 15(3): 191

Madu, U.O., Chukwu, O., Okolo, C. A., and Haruna. S. A., (2020). Effect of Ionising Radiation and Thermal Processing on Anti-Nutritional Factors of Vegetable Cowpea (*VignaSesquipedalis*) Seeds. *Premier Journal of Engineering and Applied Sciences, Vol. 1, No. 3,* 1-8

Owusu-Darko, P., Paterson, A., and Omenyo, E., (2014) Cocoyam (corms and cormels) – An underexploited food and feed resource. *Journal of Agricultural Chemistry and Environment, Vol 3,* pp 22-29

Samaa, M.S. (2019). Reducing the soluble oxalate and phytic acid in taro corm chips by soaking in calcium salt solutions. *Alexandria Journal of Food Science and Technology*, 16(2): 9 – 16.

Zanardi, E., Caligiani, A., and Novelli, E., (2018). New insights to detect irradiated food: An overview. *Food Analytical Methods, 11*, 224–235.