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# Effect of Urea Fertilizer Application on Proximate Composition of Waterleaf (*Talinum triangulare* L.) in Umudike

Orji KO\*, Oji EO

## ABSTRACT

The research investigated the effect of urea fertilizer rates on the proximate compositions of waterleaf in Umudike. The experiment design was a 3 x 6 factorial arrangement fitted into a completely randomized design (CRD) in which factor A consisted of plant fractions of 3 levels, namely: stem, leaf, and inflorescence, while factor B consisted of 6 levels of urea fertilizer, among which were – 0, 10, 20, 30, 40, and 50 kg ha<sup>-1</sup>. At 10 weeks after planting, one plant was uprooted from fertilized and unfertilized plots and partitioned into stem, leaf, and inflorescence fractions. They were washed and air-dried. The air-dried samples were ground in mill into powder which was analyzed in the laboratory. The results showed that application rates of urea fertilizer differed significantly on the proximate composition of waterleaf, although moisture content was not significantly affected. There were also significant interactions between fertilizer application and plant fractions. The results also showed that substantial percent concentration of carbohydrates and caloric value was observed in the stem of waterleaf; whereas crude protein was significantly concentrated in the leaf part. However, crude fats, fibre and dry matter significantly concentrated in the inflorescence.

**Keywords:** Plant fractions, stem, leaf, inflorescence, interaction

## 1. INTRODUCTION

Waterleaf (*Talinum triangulare* L.) is an herbaceous vegetable crop originating and cultivated in Africa, Asia, and Central and South America (USDA and NRCS, 2020). It belongs to the family of crop plants known as Portulacaceae and has other common names such as Ceylon spinach, Surinam purslane, Philippine spinach, Grassé grand pourpier, Blatt-ginseng, Lustrosa-grande, Espinaca de Java, and Sweetheart (USDA and NPGS, 2022). Waterleaf is a crop that grows and matures for a very short time period, although it grows all year round as a perennial crop if it receives much water especially in the dry season. This crop can survive in different climatic and marginal soil conditions (de Oliveira Amorim *et al.*, 2014). Waterleaf can also be grown in the fields, lawns, pots, or polythene bags. Waterleaf is a perennial and herbaceous crop plant that grows erect up to the height of 10 feet. It has swollen roots with obtuse-

angular, hairless, and succulent stems (Aja *et al.*, 2010). Stem branches have two lateral and basal buds. The leaves have spiral arrangements and are more clustered at the top of the stem. The leaf blades have a spoon shape. They are succulent and have indented tips. The light-green stems of waterleaf are smooth and erect. Also, the cross-sections of mature stems have a cylindrical shape tapering at each end (Nya and Eka, 2015).

Waterleaf (*Talinum triangulare*) is relatively hardy and adaptable, but it thrives best under specific climatic and soil conditions. Waterleaf prefers warm temperatures that fall between 25 °C and 30 °C. It is a tropical crop that thrives in areas with a persistent warm condition. It needs about 1,200 to 2,000 mm rainfall annually that is well-distributed throughout the year. Application of irrigation is required in drier areas. High humidity conditions are important for the growth of waterleaf. The plant does well in humid tropical and subtropical regions. Waterleaf thrives better under full sunlight, although it can tolerate incomplete shade. It needs a minimum of 4-6 hours of sunlight/day for optimal growth. It grows best in well-drained, loamy soils rich in organic matter. It can also thrive in sandy loam and clay loam soils with a pH between 5.5 and 7.0. It prefers slightly acidic to neutral soils. Good drainage is vital as waterleaf does not tolerate waterlogged conditions or poorly drained soils (Schippers, 2000).

Waterleaf is rich in Ca, Mg, K, vitamins, crude protein, alpha-tocopherols, beta-tocopherols, total lipids, and essential oils. It is rich in minerals, amino acids, and ascorbic acid, which helps prevent scurvy. Waterleaf is rich in indigestible fibre, which aids in digestion. This plant is used as a natural pigment for dye colorants (Swarna *et al.*, 2013). However, people should not consume raw waterleaf in large amounts because it contains soluble oxalates, which may result in kidney stones and low amounts of hydrocyanic acid content that is lower than the dose range between 50 and 300 mgkg<sup>-1</sup> of body weight (Eleazu and Eleazu, 2013). However, the soluble oxalates, nitrates, and nitrites of waterleaf are reduced by 50 % to negligible amounts when it is cooked (Agunbiade *et al.*, 2015; Willie and Eze, 2016). It is not advisable to integrate waterleaf into infant meals due to the presence of antinutrients in it (Schippers, 2000). Waterleaf also contains chemical substances that prevent colon and breast cancers because of its squalene content (Kristine *et al.*, 2015). More so, waterleaf has some chemical compounds that can prevent cardiovascular diseases such as stroke and obesity (Aja *et al.*, 2010). Waterleaf can form part of a weight-loss diet due to its high fibre content, and its leaves are applied in the treatment of several diseases such as measles (Oluwole *et al.*, 2003). In the same vein, the extracts of leaf and root of waterleaf are important in the treatment of asthma, fresh cuts, scabies, anaemia, and high blood pressure or hypertension (Ogunlesi *et al.*, 2010).

Many researchers have successfully done several morphological and physiological studies of waterleaf with poultry manure and NPK fertilizer, but there is a dearth of information on urea fertilizer application in respect to the nutritional composition of this crop. Hence, this study aims at determining the effect of application of urea fertilizer on the proximate composition of waterleaf in Umudike agro-ecosystem.

## 2. MATERIALS AND METHODS

The researcher did this study at the research and training farm of the College of Crop and Soil Sciences of Michael Okpara University of Agriculture, Umudike. Umudike is situated at a latitude of 5° 29' N and longitude of 7° 33' E with an altitude of 122 m above sea level and annual rainfall in the range of 3000 to 3500 mm and a mean annual temperature of 27 to 35 °C. The Researchers slashed, ploughed, harrowed, and ridged the site with tractor-coupled implements. There were 18 ridges and the length of each of the ridges was 3.50 m. The space between the two ridges was 1.0 m. The Researchers planted the waterleaf stems on 12<sup>th</sup> August, 2024, during the peak of the rainy season. The Researcher planted the waterleaf stem cuttings measuring 5 cm in length at a spacing of 100 cm between ridges and 10 cm within ridges to record 55-plant/ridge. The Researchers planted the stem cuttings at a depth 2 cm into the soil to ensure good contact between the stem base and the moist soil so as to promote root establishment. They weeded the farm at 2 - week interval. The research had a randomized complete block design (RCBD) with six treatments which included - 0, 10, 20, 30, 40, and 50 kg ha<sup>-1</sup> of Urea fertilizer. These six treatments had 3 replications which gave 18 plots in the field. The Experimenter bought waterleaf stems and urea fertilizer from Umudike Market in Ikwuano LGA., Abia State and applied the fertilizer 2 weeks after planting. At 10 weeks after planting (WAP), the Researcher uprooted one plant from fertilized and unfertilized plots across the three replicates and partitioned them into stem, leaf, and inflorescence fractions. They were washed, sliced into pieces, and air-dried. The Researcher ground the air-dried plant samples into powder in mill and took them to the laboratory for analysis of proximate composition (moisture, carbohydrates, crude protein, crude fat, ash, and crude fiber) following the methods described by Umeh and Ogbuagu (2010). The experiment was a 3 × 6 factorial fitted into completely randomized design (CRD) in which factor A consisted of plant fractions of 3 levels, namely: stem, leaf, and inflorescence while factor B consisted of 6 levels of urea fertilizer among which were - 0, 10, 20, 30, 40, and 50 kg ha<sup>-1</sup> to obtain 18 treatment combinations and replicated thrice to get 54 test observations in the laboratory. The Researchers

analyzed the data using the statistical package of analysis of variance for a 3 x 6 factorial arranged in completely randomized design (CRD) as described by Obi (2001) and tested a significant difference between two means at 0.05 % probability after mean separation using Fisher's least significant difference (F-LSD).

#### Determination of Moisture

The oven drying method was used to determine moisture content and 1.5 g of a well-mixed sample was appropriately measured in a clean, dried crucible (W1). The W1 crucible was kept in the oven between 100 and 105 °C for 6-12 hours until a constant weight was obtained. Then, the crucible was put in the desiccator for 30 min to cool. After cooling, it was measured again (W2). The percent moisture was calculated by the following formula:

$$\% \text{ moisture} = \frac{w_1 - w_2}{w_1} \times \frac{100}{1}$$

Where:

W<sub>1</sub> = Initial weight of crucible + Sample 1

W<sub>2</sub> = Final weight of crucible + Sample

Note: Moisture-free samples were used for further analysis.

#### Ash Content Determination

For the ash determination, a clean, empty crucible was put in muffle furnace at 600 °C for one hour and cooled in a desiccator and then weight of empty crucible was recorded (W1). One gram of each of the samples was measured in crucible (W2). The sample in the crucible was placed over a burner with the help of blowpipe, until it is charred. Then the crucible was put in a muffle furnace at 550 °C between 2 and 4 hours. The appearance of gray white ash showed a complete oxidation of all organic matter in the sample. After the formation of ash, furnace was put off. The crucible was cooled, and measured (W3).

Percent ash was calculated by the following formula:

$$\% \text{ Ash} = \frac{w_3 - w_1}{w_2 - w_1} \times \frac{100}{1}$$

#### Crude Protein Determination

The Researchers applied kjeldahl method to determine the crude protein in the samples. 0.5 – 1.0 g of dried samples was put into a digestion flask. 10-15 ml of concentrated H<sub>2</sub>SO<sub>4</sub> and 8 g of digestion mixture i.e. K<sub>2</sub>SO<sub>4</sub>; CuSO<sub>4</sub> (8:1) was added. The flask swirled in order to mix the contents thoroughly then placed on heater to start digestion till the mixture became clear (blue green in colour). It needed 2 hours to complete. The digest was cooled and transferred to 100ml volumetric flask and volume was made up to mark by the addition of distilled water. Distillation of the digest was performed in Markam still Distillation Apparatus (Khalil and Manan, 1990). Ten million of digest was introduced in the distillation tube and 10 ml of 0.5 N NaOH was gradually added through the same way. Distillation was continued with the addition of 4 % boric acid solution with few drops of modified methyl red indicator for at least 10 – 20 minutes. During distillation, yellowish colour appeared to form NH<sub>4</sub>OH. The distillate was then titrated against standard 0.1N HCl solution till the appearance of pink colour. A blank was also used to run through all the steps as described above. Percent crude protein content of the sample was calculated by using the following formula:

$$\% \text{ crude protein} = \% \text{ N} \times 0.25$$

The nitrogen content % N of the sample is given by the formula below;

$$\% \text{ N} = \frac{\text{Tv} \times \text{Na} \times 0.014 \times 1 \times 100}{\text{G} \times \text{V}_2}$$

Where Tv = Titre value of acid (cm<sup>2</sup>)

Na = Concentration or normality of acid

V<sub>1</sub> = Volume of distilled water used for distilling the digest (50 cm<sup>3</sup>)

$V_2$  = Volume of aliquot used for distillation (10 cm<sup>3</sup>)  
 $G$  = Original weight of sample used.

### Determination of Crude Fat

The Researchers determined the Crude fat by ether extract method using Soxhlet apparatus. Approximately 1 g of moisture-free sample was wrapped in a filter paper and placed in a fat-free thimble and then introduced in the extraction tube. A weighed, clean, and dry receiving beaker was filled with petroleum ether and fitted into the apparatus. The water and heater turned on to start extraction. After 4-6 siphoning, the ether was kept to evaporate and the beaker was disconnected before last siphoning. The extract was transferred into a clean glass dish with ether washing and the ether evaporated on water bath. The dish was then placed in an oven at 105 °C for 2 hours and cooled in a desiccator. The percentage crude fat was determined by using the following formula:

$$\% \text{ Crude Fat} = \frac{\text{wt. of ether extract} \times 100}{\text{wt. of sample}}$$

### Determination of Crude Fiber

The Researchers digested a moisture -free and ether-extracted sample of crude fiber made of cellulose with diluted H<sub>2</sub>SO<sub>4</sub> and then with diluted KOH solution. The undigested residue collected after digestion was ignited and the loss in weight after ignition was recorded as crude fibre.

#### Reagents:

Solution of sulphuric acid (0.128M) 7.1 ml, 96 % per 1000 ml of distilled water;

Solution of Potassium hydroxide (0.223M) and 12.5 g per 1000 mL with distilled water + Acetone (foam suppresser)

#### Procedure:

The Researchers weighed about 0.153 g sample ( $W_0$ ) and transferred to porous crucible. The crucible was then placed into Dosi-fiber unit and the valve kept in "OFF" position. 150 ml of preheated H<sub>2</sub>SO<sub>4</sub> solution and some drops of foam-suppresser was added to each column. The cooling circuit was then opened and the heating elements turned on (power at 90 %). The power was reduced to 30 % and left for 30 minutes when it started boiling. The Valves were opened for drainage of acid and distilled water was used to rinse it three times to completely ensure the removal of acid from the sample. The same procedure was used for alkali digestion by using KOH instead of H<sub>2</sub>SO<sub>2</sub>. The sample was dried in an oven at 150 °C for 1 hour and allowed to cool in a desiccator before being weighed ( $W_1$ ). The sample crucibles were then kept in a muffle furnace at 55 °C for 3-4 hours. They were cooled in a desiccator and weighed again ( $W_2$ ). Calculations were done by using the following formula:

$$\% \text{ Crude fibre} = \frac{w_1 - w_2}{W_0} \times \frac{100}{1}$$

## 3. RESULTS & DISCUSSION

Data in Table 1 showed that carbohydrates and crude protein concentrations were significantly increased ( $P \leq 0.05$ ) by various application rates of urea fertilizer. The maximum percent concentration of carbohydrate (53.90) was recorded at 40 kg ha<sup>-1</sup> fertilizer application, which was followed by the 50 kg ha<sup>-1</sup> application rate (50.72 %). The maximum percent concentration of carbohydrate was found in the stem and was followed by the inflorescence, which significantly gave 50.79 %. Also, there were significant interactions between urea fertilizer application rates and plant fractions. The interaction between 30 kg ha<sup>-1</sup> application rate and stem fraction gave the maximum percent carbohydrate yield (67.72). More so, the plots treated with 50 kg ha<sup>-1</sup> rate of fertilizer application produced the highest % concentration of crude protein which was followed by 40 and 30 kg ha<sup>-1</sup> rate of application. The crude protein increased with an increasing rate of urea application. Table 1 also showed that percent concentration of crude protein was significantly different in the leaf compared to other plant fractions. In the same vein, crude protein concentration was significant in the inflorescence for interaction between the fertilizer application rate of 50 kg ha<sup>-1</sup> and plant fractions. The significant effect of fertilizer application and its interactions on carbohydrates and crude protein was attributed to the absorption of urea fertilizer application in the form of ammonium ion (NH<sub>4</sub><sup>+</sup>)

by the waterleaf crop plants. This result is in agreement with the findings of Ezeocha *et al.* (2014), who reported significant difference on starch and crude protein of aerial yam by the application of poultry manure. In a related development, significant differences ( $P \leq 0.05$ ) were observed in crude fibre and crude oil by the application of urea fertilizer (Table 2).

**Table 1:** Effect of urea fertilizer application on carbohydrates [CHO] and crude protein [CP] of waterleaf at 10 weeks after planting (WAP)

Urea fertilizer (kg/ha)	Stem CHO	Leaf CHO	Inflorescence CHO	Mean	stem CP	Leaf CP	Inflorescence CP	Mean
0	64.08	32.07	38.69	41.00	6.56	21.44	5.69	11.23
10	62.53	29.56	35.85	44.95	6.13	22.31	5.72	11.39
20	58.32	31.27	35.81	45.98	6.25	23.19	5.91	11.78
30	67.72	32.91	61.08	41.97	7.00	22.31	0.75	12.69
40	64.76	30.33	57.07	53.90	7.50	23.19	7.88	12.70
50	59.26	36.44	57.05	50.72	7.44	22.75	8.51	12.90
Mean	66.11	32.18	50.97		6.73	22.53	7.08	
F- LSD (0.0.5) for fertilizer (F) = 4.99					1.33			
F- LSD (0.0.5) for plant fractions (P) = 3.53					0.96			
F- LSD (0.0.5) for F x P interaction = 8.64					2.35			

**Table 2:** Effect of urea fertilizer application on crude fibre and fats of waterleaf at 10 weeks after planting (WAP)

Urea fertilizer (kg/ha)	Plant fractions		(Fibre) Inflorescence	Mean	Stem	Plant fractions (fats)		Mean
	stem	Leaf				Leaf	Inflorescence	
0	11.28	12.34	26.10	15.57	4.66	2.84	4.32	3.93
10	9.88	13.36	25.20	15.15	3.14	3.08	4.33	3.52
20	10.40	14.80	23.10	15.10	2.98	3.11	3.89	3.33
30	10.28	12.70	22.10	16.03	5.06	2.98	4.80	4.28
40	12.46	13.16	19.80	16.14	2.86	1.88	3.98	2.91
50	14.26	15.60	22.50	17.62	2.99	1.38	4.26	3.54
Mean	11.51	13.60	23.13		3.61	2.88	4.26	
F- LSD (0.0.5) for fertilizer (F) = 1.62					0.35			
F- LSD (0.0.5) for plant fractions (P) = 1.15					0.25			
F- LSD (0.0.5) for F x P interaction = 2.81					0.61			

The highest significant concentration of fibre (17.62 %) was recorded from the application rate of 50 kg ha<sup>-1</sup>. Also, the percent concentration of fibre was significant in the inflorescence and leaf with the highest concentration recorded in the inflorescence of the plant fractions. There were significant interactions between fertilizer application and plant fractions with varying percent concentrations of fibre in the inflorescence, while the interaction between 50 kg ha<sup>-1</sup> application rate and stem fractions recorded the highest % concentration of fibre. Furthermore, the application rate of 30 kg ha<sup>-1</sup> urea produced the maximum percent concentration (4.28) of crude oil in the leaf, whereas the stem gave 3.61 % of it and the inflorescence had 4.26 % concentration. Also, there were varying percent concentrations of the crude oil in the interaction between fertilizer application rates and plant fractions. However, the interaction between fertilizer application rate of 30 kg ha<sup>-1</sup> and stem plant fraction gave the maximum concentration of the crude oil. The significant effect of fertilizer application and its interactions on carbohydrates and crude protein was attributed to the absorption of urea fertilizer application in the form of ammonium ion (NH<sub>4</sub><sup>+</sup>) by the waterleaf crop plants. This result agreed with the report of Falak

et al. (2011), who observed significant effect on the nutrient composition of potato by the application of NPK fertilizer (Table 2). Table 3 showed that the application of urea fertilizer did not have a significant affect ( $P \geq 0.05$ ) on the moisture content of waterleaf, nevertheless, the stem and leaf fraction, respectively produced significant concentrations of 89.77 and 90.98 %. The significant effect of urea application on moisture content is due to the higher surface area of the stem and leaf which enabled them to store more moisture compared to inflorescence. The application rate of 30  $\text{kg ha}^{-1}$  x inflorescence interaction and 20  $\text{kg ha}^{-1}$  x inflorescence interaction, respectively produced 88.93 % and 88.40 % moisture.

**Table 3:** Effect of Urea fertilizer on moisture content and ash of waterleaf at 10 weeks after planting (WAP)

Urea fertilizer (kg/ha)	Stem	Plant fractions (MC)		Mean	Plant fractions		(Ash) Inflorescence	Mean
		Leaf	Inflorescence		Stem	Leaf		
0	88.76	71.73	82.63	18.63	18.26	26.94	6.58	14.26
10	99.52	81.20	81.20	6.77	6.77	29.18	6.06	14.00
20	89.72	88.40	88.47	7.84	7.84	29.34	31.26	22.81
30	90.11	88.93	88.40	19.34	19.34	30.24	28.54	26.04
40	91.19	78.80	90.18	9.96	9.96	28.86	7.26	15.36
50	92.87	83.12	87.08	10.05	10.05	27.94	7.86	15.28
Mean	90.98	82.03	87.06	12.04	12.04	28.75	14.59	
F- LSD (0.0.5) for fertilizer (F) = NS					2.01			
F- LSD (0.0.5) for plant fractions (P) = 5.93					1.42			
F- LSD (0.0.5) for F x P interaction = 14.53					3.48			

On the other hand, the application of urea fertilizer significantly ( $P \leq 0.05$ ) increased the percent concentration of ash in respect to the control (Table 3). The application rates of 30 of urea fertilizer gave the highest significant concentration (26.04 %), while 20  $\text{kg ha}^{-1}$  rate of application had 22.81 % of ash. In the same vein, inflorescence contained 14.59 % concentration of ash while the leaf had 28.75 %. The application rate of 30  $\text{kg ha}^{-1}$  x inflorescence interactions significantly increased the ash content of waterleaf. The increment in ash content is due to the high content of minerals in waterleaf at this particular rate. However, a further increase in the rate of fertilizer application led to the decline in the ash content, which might be due to the higher concentration of minerals in the soil that brought about out flow of the minerals from the test crop to the soil following osmosis. This result agreed with the findings of Ojeniyi and Adejebi (2002), who obtained a similar result on *Amaranthus* from the application of poultry manure.

**Table 4:** Effect of Urea fertilizer application on dry matter yield (%) and caloric value ( $\text{KJ kg}^{-1}$ ) of waterleaf at 10 weeks after planting (WAP)

Urea fertilizer (kg/ha)	Plant fractions (DM)			Mean	Plant fractions (CV)			Mean
	Stem	leaf	Inflorescence		Stem	Leaf	Inflorescence	
0	11.24	12.61	28.27	17.37	305.04	257.08	290.88	284.33
10	7.48	8.30	18.80	11.53	349.10	245.24	296.61	296.98
20	10.28	9.89	11.60	10.59	341.94	238.99	202.05	260.99
30	9.59	8.82	11.06	9.82	306.82	243.14	221.44	257.13
40	10.44	7.13	21.18	12.92	324.62	241.32	311.66	292.53
50	12.34	7.39	16.88	12.20	315.55	242.74	299.86	286.05
Mean	10.23	9.02	17.97		323.84	244.42	270.42	
F- LSD (0.0.5) for fertilizer (F) = 1.29					27.04			
F- LSD (0.0.5) for plant fractions (P) = 0.91					19.12			
F- LSD (0.0.5) for F x P interaction = 2.24					46.84			

Data in Table 4 indicated that the application of urea fertilizer produced a significant ( $P \leq 0.05$ ) concentration of dry matter, nevertheless, the control produced the highest concentration (17.37 %) of dry matter. However, the inflorescence significantly gave more concentrations of dry matter yield (17.97 %) than the stem (10.23 %). The dry matter yield depicts the quantity of proximate and mineral compositions in the test crop. The interactions between the fertilizer application and plant fractions produced varying percent concentrations of dry matter yield with the control producing the highest concentration of 28.27 % in the inflorescence. Moreover, the application of urea fertilizer significantly gave varying concentrations of the caloric values ( $\text{KJkg}^{-1}$ ). So, the application rate of  $10 \text{ kg ha}^{-1}$  produced the highest energy concentration ( $296.98 \text{ KJkg}^{-1}$ ). The inflorescence significantly produced more energy values than the stem.

In the same vein, the interaction between the fertilizer application rate of  $50 \text{ kg/ha}$  and plant fractions significantly recorded varying concentrations of energy value ( $299.86 \text{ KJkg}^{-1}$ ) in the inflorescence compared to other interactions. This high significant energy value results showed that waterleaf is a good source of energy to the body. This result agreed with the result of Habtamu *et al.* (2015), who reported similar findings on okra.

#### 4. CONCLUSION

The findings of this research revealed that urea fertilizer application rates produced varying significant differences on the proximate compositions of *Talinum triangulare* in Umudike agro-ecosystem. Moreover, this research reports revealed significant effects of urea fertilizer application on the percent concentrations of carbohydrates and caloric value in the waterleaf stem, whereas the leaf fraction significantly increased crude protein. On the other hand, inflorescences had significant concentrations of crude fats, crude fibre and dry matter content.

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#### Conflict of interest

The authors declare that there are no conflicts of interests.

#### Ethical approval

In this article, as per the plant regulations followed in the Department of Crop and Horticultural Sciences, College of Crop and Soil Sciences, Michael Okpara University of Agriculture, Umudike, P. M. B. 7267 Umuahia, Abia State, Nigeria; the authors observed the effect of urea fertilizer application on proximate composition of Waterleaf (*Talinum triangulare* L.) in Umudike. The ethical guidelines for plants & plant materials are followed in the study for observation, identification & experimentation.

#### Informed consent

Not applicable.

#### Data availability

All data associated with this study will be available based on the reasonable request to corresponding author.

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