ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 03(A), pp. 30693-30696, March, 2019

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

CHALK CHROMATOGRAPHY: A LOW-COST INVESTIGATORY PROJECT FOR HIGH-SCHOOL STUDENTS

Nagaraj*G., Sukumar A and Tangpu V

Zoology Section, Department of Education in Science and Mathematics, Regional Institute of Education, (National Council of Educational Research and Training), Mysuru, Karnataka, India

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1003.3105

ARTICLE INFO

Article History:
Received 4th December, 2018
Received in revised form 25th January, 2019
Accepted 18th February, 2019
Published online 28th March, 2019

Key Words:

Retardation factor, creative minds, opinionnaire, colours, improvisation.

ABSTRACT

Science experiments and projects are effective tools in achieving learning by doing. Alarmingly, lack of necessary equipments seriously affects Science teaching, which in turn compels improvisation of low-cost apparatus/experiments. In this context, present study aims to (1) design and propose an innovative and low-cost project on chalk chromatography, (2) determine and compare the Retardation factor / Relative flow (Rf) value of 12 colour inks using it and (3) find out the opinion of teacher trainees about this working model. The method includes marking of twelve coloured ink on twelve chalks and running chromatography using water as solvent. The chromatogram revealed that orange colour had highest Rf value (0.925) and pink had the lowest (0.317). It is to be noted that, Rf values calculated are not consistent hence, this technique is not to be used for analytical purpose. Excepting that limitation, the favorable opinion and remarks of almost all the future teachers (N = 128) establishes that, present working model is innovative, easily improvisable, no/ low-cost, can help for joyful learning and be able to ignite the creative minds of school children. Hence, the current activity is assertively proposed as a novel idea and a low/ no-cost project for high school students for active learning even at home and to motivate them to go beyond text book.

INTRODUCTION

Holistic development of the child which is the aim of the education is only achievable with pragmatic approach which imparts learning by doing and experiencing things. Science experiments and projects are very efficient tools in creating interest in learning, developing skills, nurturing creativity, imbibing scientific attitude and training in scientific method (Agbogun 1991). It encourages students to be an independent learner, critical thinker and problem solvers (Shymansky *et al*., 1990; Carin and Bass, 2001; Kolb, 1984). It also facilitates hands-on and minds-on learning which improves the quality of instruction in-turn the education (Saroja and Evelyn, 2014). Further, Ogunniyi (1982) and Yara (2010) said that laboratory occupies central position in Science instruction where theory is practiced with lots of activities. Further, Adeniran (2006) and Yara (2010) stated that laboratory strategy provides non-threatening, realistic and concrete approach to learn Science. In addition, Oyedeji (2000) found that students taught with laboratory instruction method performed significantly better than those taught with traditional lecture and text book method.

Alarmingly, Ziad *et al*. (2014) and Hamidu *et al*. (2014) reported that lack of necessary equipments and time constraint are the top barriers of effective Science teaching. In this context, as an attempt to find solution to such long existing problems of many schools, the present study aims to (1) design and propose an innovative, easily improvisable and low cost project on chalk chromatography, (2) determine and compare the Retardation factor / Relative flow (R_f) value of 12 colour inks using it and (3) find out the opinion of teacher trainees about this working model.

Chromatography is a laboratory technique to separate a compound from the mixture. The mixture is dissolved in a fluid called mobile phase, which carries it through a structure holding another material called stationary phase. The various constituents of the mixture travel at different speed causing them to separate. It has different types like column, thin layer and paper; and ascending, descending and circular chromatography.

Review of Related Studies

**Corresponding author:* Nagaraj G
Department of Education in Science and Mathematics, Regional Institute of Education, (National Council of Educational Research and Training), Mysuru, Karnataka, India

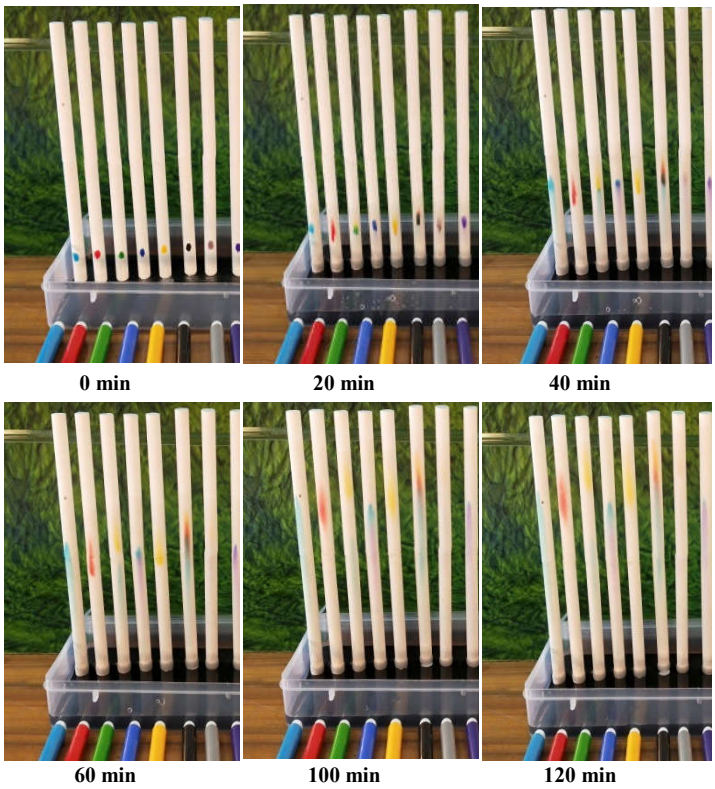
When the review of earlier studies was made, there are some videos found in the YouTube which demonstrate chalk chromatography. To mention few, Anne (2002), Afzal (2018), Angela (2013) and Brad (2014) made round mark around the chalk stick using sketch pens and performed the activity/experiment using alcohol as mobile phase. On the other hand, using water as mobile phase Naresha (2015) performed chalk chromatography in opaque plastic box with closed lid (hence, ascending of colours was not seen), Doktrorklawonn (2018) used glass Petri-dish as solvent-reservoir. Further, teachers from Sunday Science School (SSS, 2014) Mumbai, used green food colour as solute and water as solvent, Arham (2017) said that green food colours contains a very little artificial dye and Reyshan (2017) separated green pigments using chalk and ethanol. Gardnertoo (2013) made a video similar to the present study, using 12 chalks and 12 colour sketch pens in one glass tray. But it did not have audio, no explanation and no calculation of R_f values. On the other hand, using paper chromatography Derek Williams (2015) determined the R_f value of commercial dye used in candy. Further, it was observed from the review that all the available videos demonstrated the ascending of colour but none of them determined the R_f value which is being done in the present study.

MATERIALS AND METHODS

Firstly, the required no/ low-cost items like white chalks, different coloured sketch pens, a pencil box, gum and a glass rod was collected. White chalks were wiped with cotton to remove any superficially adhering chalk powder. A chalk stick was crushed and grinded with water to make paste. To run the chromatogram for a longer duration (2 hrs) in order to get clear and reliable R_f value the length of the chalk stick was increased by joining two sticks; for that, in-between ends of two chalk, little chalk paste was applied and allowed to dry for 24 hrs. Similarly, 12 sets of chalks were prepared and made to stand in a row in a pencil box. To avoid falling, a glass rod was placed as back support (using 2 burette stands) and the tips of chalks were fixed with it using gum (Fevicol). One cm above from the bottom of the chalk a big dot was marked using colour sketch pen. Likewise, 12 different colours were marked on those 12 chalks.

Poured water in the pencil box about half centimeter height. Due to capillary action water rises up in the chalk and the colour inks were also moved along with the water. Here, water is the mobile phase or solvent and the coloured ink is the solute. This chromatography process was allowed to run for 2 hrs and the entire process was video recorded and photographed using a smart phone. Photos showing the movement of the ink and water at different period were presented in picture 1. After 2 hrs the raised level of solvent and solute were marked and the distance travelled were measured using scale and pencil. As the solute (ink) leaves a big stretch of mark, in order to find the midpoint the average of upper and lower level was taken. Further, R_f value was calculated and tabulated (table 1) using the following formula:

$$R_f = \frac{\text{Distance moved by the solute}}{\text{Distance moved by the solvent}}$$



Picture 1 Picture showing ascending flow of different colours on chalk in relation to time

Additionally, using real items, photos and videos present chalk chromatography project was demonstrated to the I to IV year B. Sc. B. Ed (CBZ) teacher trainees (N = 128) of RIE (NCERT), Mysuru, in order to get their opinion about this project. For that, an opinionnaire consisting of 10 statements with Likert scale as listed in table 2 was employed and their opinion on each statement was calculated year-wise and computed the statement-wise average.

RESULT AND DISCUSSION

It can be observed from Picture 1 that, interestingly black colour separated in to three different colours viz. orange red and sky blue. Similarly, light-green blue, gray, pink, brown and dark green colours showed two different colours each (picture 1 and table 1). Remaining colours viz. red, orange, sky blue, yellow and violet showed single colour only (however, violet had negligible amount of sky blue).

Further, orange component of blue colour ink reached the highest of 14.1 cm and pink part of pink ink moved to the lowest height of 7.4 cm and it was the slowest moving colour among all. Another interesting observation is that, wherever yellow colour present, it was on top than it's co-colours. Additionally, some colours showed short stretch of band while others had long stretch; for example orange (1.7 cm) and red (2.7 cm) showed short band, while pink extended to 10.3 cm (1.5 to 11.8 cm), black to 9.1 cm (5.0 to 14.1 cm) and sky blue to 6.9 cm (5.5 to 11.4 cm). Besides that, gray colour got faded and almost not seen at the end.

Table 1 Comparison of R_f values of different coloured inks

SN	(a) Ink colour	(b) Water (solvent) level (cm)	(c) Number of colours found	(d) Name of colours found	(e) Lower level of ink (solute) (cm)	(f) Higher level of ink (solute) (cm)	(g) Width of the ink band (cm)	(h) Midpoint ink level (e+f)/2 (cm)	(i) R_f value (i/b)
1	Sky blue	14.5	1	Sky blue	5.5	11.4	6.9	8.45	0.582
2	Red	14.3	1	Red	10	12.7	2.7	11.35	0.793
3	Light green	14.2	2	Yellow	11.8	13.2	1.4	12.5	0.880
				Sky blue	4.0	8.8	4.8	6.4	0.450
4	Blue	14.0	2	Sky blue	9.5	11.0	1.5	10.25	0.732
				Violet	5.5	9.5	4.0	7.5	0.535
5	Yellow	14.2	1	Yellow	10.2	13.2	3.0	11.7	0.823
6	Black	14.8	3	Orange	13.3	14.1	0.8	13.7	0.925
				Red	12.2	13.0	0.8	12.6	0.851
				Sky blue	5.0	11.8	6.8	8.4	0.567
7	Gray	14.2	2	Yellow	12.2	13.2	1.0	12.7	0.894
				Purple	6.0	11.2	5.2	8.6	0.614
8	Violet	14.2	1	Violet	7.5	10.4	2.9	8.95	0.630
9	Pink	14.0	2	Yellow	10.5	11.8	1.3	11.15	0.796
				Pink	1.5	7.4	5.9	4.45	0.317
10	Brown	14.1	2	Orange	11.2	12.8	1.6	12.0	0.851
				Sky blue	5.0	7.5	2.5	6.25	0.443
11	Orange	14.0	1	Orange	11.3	13.0	1.7	12.15	0.867
12	Dark green	13.0	2	Yellow	10.4	11.5	1.1	10.95	0.842
				Sky blue	6.8	10.4	3.6	8.6	0.661

Table 2 Opinion of teacher trainees about chalk chromatography

SN	Statement/ item	Class/ Year	I strongly agree		I agree		Uncertain		I disagree		I strongly disagree	
			n	%	n	%	n	%	n	%	n	%
1	It explains the chromatography concept well	I	24	58.5	17	41.5						
		II	12	35.3	22	64.7						
		III	14	47	16	53						
		IV	12	52.2	11	47.8						
		Average %	**48.25**		**51.75**							
2	R_f values are reliable	I	5	12.2	27	65.9	9	21.9				
		II	3	8.8	20	58.8	11	32.4				
		III	4	13	21	70	5	17				
		IV			12	52.2	11	47.8				
		Average %	**8.50**		**61.72**		**29.78**					
3	School students can easily do this projects	I	37	90.2	4	9.8						
		II	26	76.5	8	23.5						
		III	22	73	7	23	1	4				
		IV	18	78.3	5	21.7						
		Average %	**79.5**		**19.5**		**1**					
4	It is an innovative activity	I	21	51.2	19	46.3	1	2.5				
		II	21	61.8	11	32.4	2	5.8				
		III	18	60	12	40						
		IV	10	43.5	13	56.5						
		Average %	**54.13**		**43.8**		**2.08**					
5	This can promote improvisation skill	I	21	51.2	17	41.5	1	2.4	2	4.9		
		II	20	58.8	13	38.2	1	3				
		III	13	43	15	50	2	7				
		IV	14	60.9	8	34.8	1	4.3				
		Average %	**53.48**		**41.13**		**4.2**		**1.23**			
6	This can encourage creativity	I	27	65.9	14	34.1						
		II	24	70.6	7	20.6	3	8.8				
		III	18	60	11	36	1	4				
		IV	13	56.5	8	34.8	2	8.7				
		Average %	**63.25**		**31.37**		**5.4**					
7	This can make learning easy & joyful	I	31	75.6	10	24.4						
		II	23	67.6	11	32.4						
		III	19	63	10	33	1	4				
		IV	10	43.5	13	56.5						
		Average %	**62.43**		**36.57**		**1**					
8	This can generate curiosity in learning	I	24	58.5	15	36.6	2	4.9				
		II	22	64.7	12	35.3						
		III	15	50	13	43	2	7				
		IV	8	34.8	15	65.2						
		Average %	**52**		**45.02**		**2.97**					
9	This can be a home made experiment	I	37	90.2	4	9.8						
		II	26	76.5	7	20.6			1	2.9		
		III	23	77	6	19	1	4				
		IV	15	65.2	8	34.8						
		Average %	**77.22**		**21.05**		**1**		**0.73**			
10	Will you practice it in your teaching carrier?	I		39		95.1			2		4.9	
		II		34		100						
		III	YES	30		100		NO				
		IV		23		100						
		Average %			**98.77**					**1.23**		

Note: Total number of teacher trainees (N) = 128; among them Ist year = 41, IInd year = 34, IIIrd year = 30 and IVth year = 23. Blank space indicates no value.

It is also observed from the table 1 that, orange component of black ink had the highest R_f value of 0.925, followed by yellow 0.894 and pink had lowest R_f value of 0.317. In support to the present observation, using candy dyes in paper chromatography Derek Williams (2015) found that, orange colour has high R_f value (0.287) followed by yellow (0.272), red (0.207) and purple (0.172). Such varied R_f values of different colours are due to the difference in structure, polarity and weight of the molecules. It is well known that molecules with high polarity will interact strongly with the stationary phase (chalk) which causes slow movement of the solute likewise, compounds with higher molecular weight also moves slow (Derk, 2015; MERIT studio, 2017; Reyshan, 2017). Moreover, these different R_f values indirectly indicates that chalk can be used as an effective and low-cost stationary phase. However, it was observed that the R_f values did no show consistency in the repeated confirmatory experiments/trials and hence, this technique is not to be used for analytical/research purpose.

It is surprising that the sky blue colour was found in many other colours (in light-green, blue, black, brown and dear-green). In addition, when it is alone it had R_f value of 0.582, but when it is in other colours showed different R_f values for example, in light-green 0.450, blue 0.732, black 0.567, brown 0.443 and in dark- green 0.661. It is suggested that, students can take up such projects using many other easily available solutes like coffee, tea, dyes from candy, turmeric solution, flower and leaf extract, liquid blue etc.

Further more, it is observed from the opinion table (table 2) that, everybody (100%) agreed that chalk chromatography working model can explain the chromatography technique/ concept well (item 1). Similarly, almost all the student opined that it is an innovative activity (item 4; 97. 93%), can promote improvisation skill (item 5; 94.61%), encourage creativity (item 6; 94.62%), make learning easy and joyful (item7; 99%), and can generate curiosity in learning (item 8; 97.02%). On the other hand, as many of the trainees doubted, the inconsistency of the R_f values is the limitation of this technique.

Besides, they also opined that this activity can be done as a project even at home (item 9; 98.27%) and all of them (98.77%) are interested in practicing this activity in their teaching carrier (item 10). These favorable opinion and remarks of the prospective teachers very strongly recommends that the present working model can be used as low/ no-cost innovative project for school students.

CONCLUSION

The newly designed chalk chromatography revealed that orange colour had highest R_f value and pink had the lowest; which in turn proved that chalk can be used as an effective stationary phase. Excluding the limitation of this technique that is the inconsistency of R_f values, all other favorable opinion and remarks of almost all the teacher trainees also establishes that, the current inexpensive working model is innovative, easily improvisable, can help in joyful learning and can demonstrate chromatography technique very well. In addition, it can promote improvisation skill and ignite the creative minds of the children leading to hands-on and minds-on learning. Therefore, present chalk chromatography activity is proposed confidently as an innovative idea and low/ no-cost project for high school students for active learning even at home and to motivate them to go beyond text book.

Acknowledgements

Authors sincerely thank the teacher trainees and the Principal of Regional Institute of Education, Mysuru; and the Director of National Council of Educational Research and Training, New Delhi for their encouragement and support to carry out the study.

References

Adeniran SA. (2006). The challenges of universal basic education: The role of mathematics (secondary mathematics and UBE). Proceedings of Annual National Conference of Mathematical Association of Nigeria, Sept. 9-9, Nigeria, pp: 230-233.

Afzal M. (2018). Chalk Chromatography (Chemistry Project). https://www.youtube.com/watch?v=SVKU8UYRXJs.

Agbogun FT. (1991). Senior secondary students' perception of biologypractical. An unpublished M.Ed proposal presented at the CSET Department, University of Ilorin, Ilorin.

Angela C. (2013). Chalk Chromatography. https://www.youtube.com/watch?v=PPMtf_tWf0I.

Anne H. (2012). Chalk Chromatography Easy Science Project. https://www.thoughtco.com/chalk-chromatography-how-to-605965.

Arham J. (2017). Fun experiments-chalk chromatography. https://www.youtube.com/watch?v=1Zosz9T_EPA.

Brad S. (2014). Chalk Chromatography Demonstration. https://www.youtube.com/watch?v=o5GRfHG3EGs.

Carin A, Bass JE. (2001).Teaching science as inquiry. 9th edition, New Jersey: Prentice-Hall, Inc.

Derek W. (2015). Candy Chromatography Lab- Skittles. https://www.youtube.com/watch?v=4gT7TGm5m5Q.

Doktor-Klawonn. (2010). Chromatographie an kreide - chromatography on chalk. https://www.youtube.com/watch?v=flh-phdvojc.

Gardnertoo. (2013). Chalk Chromatography. https://www.youtube.com/watch?v=VgIiAwQZAZc.

Hamidu MY, Ibrahim AI, Mohammed A. (2014). The Use of Laboratory Method in Teaching Secondary School Students: a key to Improving the Quality of Education. Int J Sci Eng Res, 5(9): 81-86.

Kolb DA. (1984). Experiential learning: Experience as the source of learning and development. New Jersey: Prentice-Hall.

MERIT studio. (2017). Paper and chalk chromatography experiment – principle, method & demonstration. https://www.youtube.com/watch?v=uQOsBLluUZI.

Naresh B. (2015). Chalk chromatography. https://www.youtube.com/watch?v=dAgdvVJt2vo.

Ogunniyi MB. (1982). An analysis of prospective science teacher's understanding of the nature of science teaching. J. Res. Sci. Teach., 19: 25-32.

Yara PO. (2010). Adequacy of Resource Materials and Students' Mathematics Achievement of Senior Secondary Schools in Southwestern Nigeria. The Social Sciences, 5: 103-107.

Oyedeji CO. (2000). The effects of laboratory approach on students performance in geometry at the senior secondary schools. Lacoped J. Primary Sci. Noforija Epe, 2: 2-6.

Reyshan. (2017). Chalk Chromatography. https://thebestscienceproject.com/chalk-chromatography/.

Saroja D, Evelyn WZS. (2014). A study on the effectiveness of hands-on experiments in learning science among year 4 students. Int Online J Pri Ed, 3(1): 29-40.

Skymansky JA, Hedges LV, Woodworth G. (1990). A reassessment of the effects of inquiry-based science curricula of the '60s on student performance.Journal of Research in Science Teaching, 27, 127-144.

SSS -Sunday Science School. (2014). Chromatography using chalk. https://www.youtube.com/watch?v=7VO1CYNS_VM.

Ziad S, Heather F, Hiba Al-E. (2014). The importance of practical activities in school science: perspectives of independent school teachers in qatari schools.Proceedings of EDULEARN14 Conference 7th-9th July, Barcelona, Spain. ISBN: 978-84-617-0557-3 4847.

How to cite this article:

Nagaraj G., Sukumar A and Tangpu V., 2019, Chalk Chromatography: a Low-Cost Investigatory Project for High-School Students. *Int J Recent Sci Res.* 10(03), pp. 31230-31234. DOI: http://dx.doi.org/10.24327/ijrsr.2019.1003.3217

****